

TM 9-1893B

RESTRICTED

WAR DEPARTMENT

**TECHNICAL MANUAL**



**POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM  
FOR CARGO CARRIER M28 (T15)**

25 AUGUST 1943

*\*Dissemination of restricted matter.—The information contained in restricted documents and the essential characteristics of restricted materiel may be given to any person known to be in the service of the United States and to persons of undoubted loyalty and discretion who are cooperating in Government work, but will not be communicated to the public or to the press except by authorized military public relations agencies. (See also paragraph 18b, AR 380-5, 28 September 1942.)*



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ORDNANCE MAINTENANCE

**POWER TRAIN, SUSPENSION SYSTEM, HULL,  
AND HULL ELECTRICAL SYSTEM  
FOR CARGO CARRIER M28 (T15)**Prepared under the direction of the  
Chief of Ordnance

(with the cooperation of The Studebaker Corporation)

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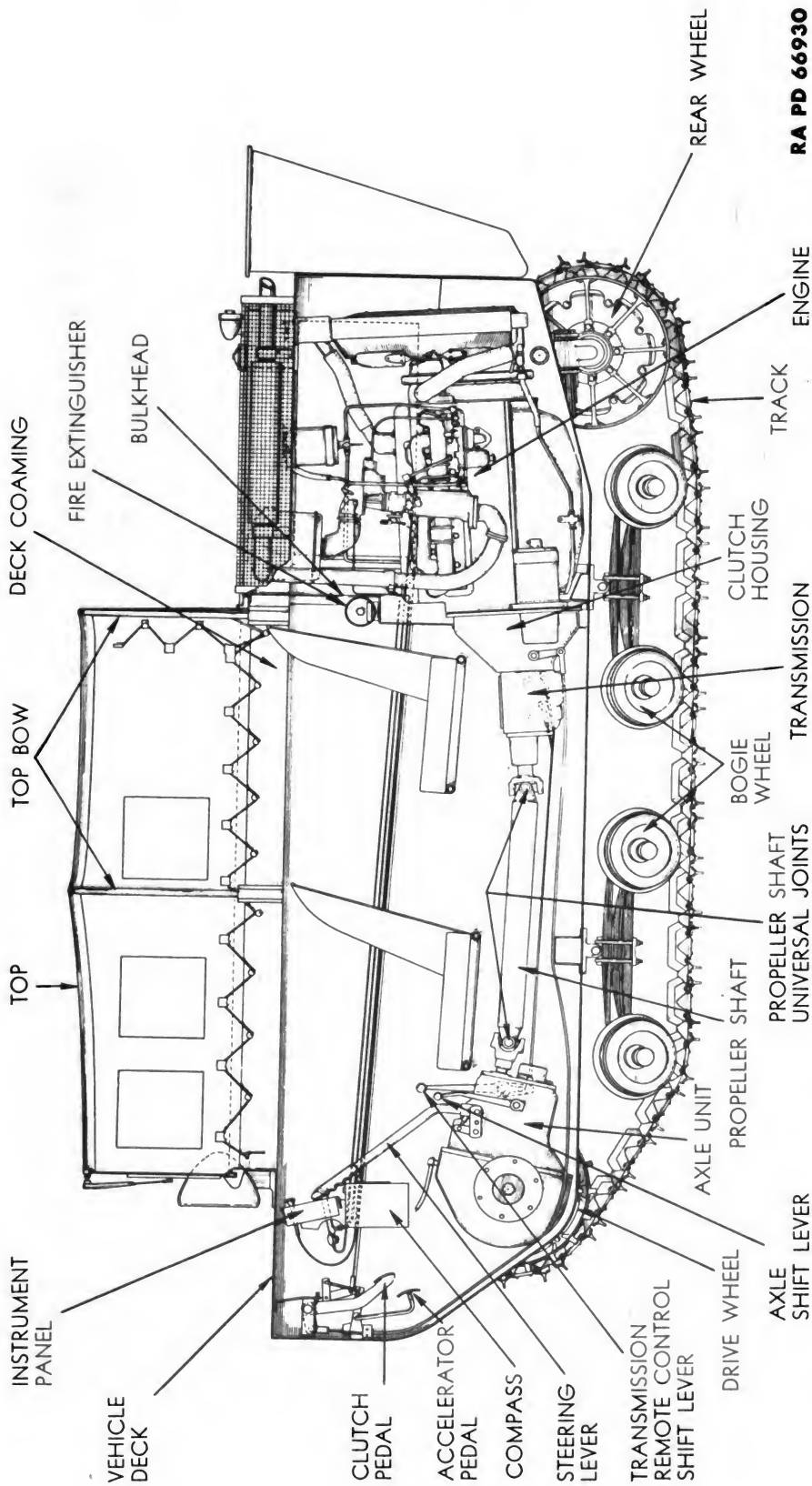


Figure 1—Cargo Carrier M28 —Longitudinal Section

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ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)

CHAPTER 1

INTRODUCTION

	Paragraph
Scope .....	1
Arrangement .....	2
Maintenance allocation .....	3

1. SCOPE.

- a. The instructions contained in this manual are for the information and guidance of personnel charged with the maintenance and repair of the Cargo Carrier M28 (T15). Information on the detailed construction of the unit, disassembly and assembly procedures, inspection, maintenance, and repair is contained in two technical manuals of the 1000-series of which this is volume B. These instructions are supplementary to those in the field and technical manuals prepared for the using arms. This manual does not contain information which is intended primarily for the using arms, since such information is available to ordnance maintenance personnel in 100-series TM's or FM's.
- b. This manual contains a description of, and procedure for, removal, disassembly, inspection, and repair of the power train, suspension system, hull, and hull electrical system.
- c. TM 9-1893A contains a description of, and procedure for, removal, disassembly, inspection, and repair of the engine, engine systems, and clutch.

2. ARRANGEMENT.

- a. The subject matter contained in this manual is grouped by chapter, the scope of each being as indicated under "Contents." Because of complexity and length, chapters have been devoted to the transmission and propeller shaft, axle differential and transmission assembly with final drives, suspension system, and hull and hull electrical system. Sections under various chapters are numbered consecutively within each chapter. Paragraphs are numbered consecutively throughout the manual.
- b. Illustrations of specific operations support and clarify the descriptive matter in the text. Exploded views of the component parts of units show the correct relation of related parts, and aid in identification. Figures are numbered consecutively throughout, and are located as near as possible to the related text. Frequent references to applicable figures are made throughout the manual.
- c. In this manual all references to units, or parts as to right or left, and front or rear, are made on the basis of the driver's right, left, front, and rear as he sits in the driver's seat facing ahead.

## INTRODUCTION

## 3. MAINTENANCE ALLOCATION.

**a. Scope.** The scope of maintenance and repair by the crew and other units of the using arms is determined by the availability of suitable tools, availability of necessary parts, capabilities of the mechanics, time available, and tactical situation. All of these are variable and no exact system of procedure can be prescribed. Many second echelon operations are often done by ordnance personnel.

**b. Allocation of Maintenance.** Indicated below are the maintenance duties for which tools and parts have been provided for the using arm and maintenance personnel. Other replacements and repairs are the responsibility of ordnance maintenance personnel but may be performed by using arm personnel when circumstances permit, within the discretion of the commander concerned. Echelons and words as used in this list of maintenance allocations are defined as follows:

**SECOND ECHELON:** Line organization regiments, battalions, companies, detachments, and separate companies (first and second echelons).

**THIRD ECHELON:** Ordnance light maintenance companies, ordnance medium maintenance companies, ordnance divisional maintenance battalions and ordnance post shops.

**FOURTH ECHELON:** Ordnance heavy maintenance companies, and service command shops.

**FIFTH ECHELON:** Ordnance base regiments, ordnance bases, arsenals, and manufacturer's plants.

**SERVICE:** Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustment of sub-assemblies or assemblies and controls.  
(Including preventive maintenance) par. 23 a (1) and (2) AR 850-15.

**REPLACE:** Consists of removing the part, sub-assembly or assembly from the vehicles and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.  
Par. 23 a (4)  
AR 850-15.

**REPAIR:** Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting and/or alining or balancing.  
Par. 23 a (3) and (5)  
in part. AR 850-15.

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****REBUILD:**

Par. 23 a (5) in part  
and (6) AR 850-15.

Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly, or assembly of the vehicle, including welding, riveting, machining, fitting, alining, balancing, assembling and testing.

**ECHELONS****CLUTCH**

	2nd	3rd	4th	5th
Clutch—replace .....	E	X		
Clutch—repair .....		X		
Clutch—rebuild .....			E	X
Controls and linkage—service and/or replace .....	X			
Controls and linkage—repair .....		X		
Housing, clutch—replace .....		X		
Housing, clutch—rebuild .....			X	

**COOLING GROUP**

Connections—replace .....	X			
Radiator assembly—replace .....	X			
Radiator assembly—repair .....		X		
Radiator assembly—rebuild .....			E	X
System, cooling—service .....	X			

**DIFFERENTIAL ASSEMBLY**

Bands, brake—service .....	X			
Bands, brake—replace and/or repair .....		X		
Controls and linkage—replace .....	X			
Controls and linkage—repair .....		X		
*Differential assembly—replace .....	*	X		
Differential assembly—repair .....		X		
Differential assembly—rebuild .....			E	X

**ELECTRICAL GROUP**

Battery—service, recharge and/or replace .....	X			
Battery—repair .....		X		
Battery—rebuild .....			E	X
Box, junction—replace .....	X			
Coil, ignition—replace .....	X			
Conduits and wiring—replace and/or repair .....	X			
Defroster assembly—replace .....	X			
Lamp assemblies—service and/or replace .....	X			
Lamp assemblies—repair .....		X		
Regulator, current and voltage—replace .....	X			
Regulator, current and voltage—service and/or repair .....		X		

\*See Notes on page 10.

## INTRODUCTION

ELECTRICAL GROUP (Cont'd)	ECHELONS			
	2nd	3rd	4th	5th
Regulator, current and voltage—rebuild .....			X	
Switch assemblies—replace .....	X			
Switch assemblies—repair .....		X		
<b>ENGINE</b>				
Bearings, crankshaft (inserts)—replace .....		E	E	X
Belt—service and/or replace .....	X			
Block, cylinder—rebuild (recondition) .....			E	X
Carburetor assembly—replace .....	X			
Carburetor assembly—repair .....		X		
Carburetor assembly—rebuild .....			X	
Cleaner, air—service and/or replace .....	X			
Cleaner, air—repair .....		X		
Condenser, distributor—replace .....	X			
Controls and linkage—service and/or replace .....	X			
Controls and linkage—repair .....	X			
Crankshaft—rebuild (recondition) .....			E	X
Dilution system, engine oil—replace .....	X			
Dilution system, engine oil—repair .....		X		
Distributor assembly—service and/or replace .....	X			
Distributor assembly—repair .....		X		
Distributor assembly—rebuild .....			X	
*Engine assembly—replace .....	*	X		
Engine assembly—repair .....		X		
Engine assembly—rebuild .....			E	X
Fan assembly—replace .....	X			
Fan assembly—repair .....		X		
Fan assembly—rebuild .....			X	
Filter assembly, oil—service and replace cartridge .....	X			
Filter assembly, oil—repair .....		X		
Flywheel—replace and/or repair .....		X		
Flywheel—rebuild (recondition) .....			E	X
Gaskets, cylinder head and manifold—replace .....	X			
Gear train, timing—replace .....		X		
Generator assembly—replace and/or repair .....		X		
Generator assembly—rebuild .....			X	
Head, cylinder—replace and/or repair .....		X		
Lines and connections, oil (external)—replace .....	X			
Lines and connections, oil (external)—repair .....		X		
Lines and connections, oil (internal)—replace and/or repair .....		X		
Manifolds—replace .....	X			
Manifolds—repair .....		X		
Motor assembly—starting—replace and/or repair .....		X		

\*See Notes on page 10.

# **ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

ENGINE (Cont'd)	ECHELONS			
	2nd	3rd	4th	5th
Motor assembly, starting—rebuild .....			X	
Pan assembly, oil—service and replace gaskets .....		X		
Pan assembly, oil—repair and/or replace .....		X		
Pistons and rings—replace .....		E	E	X
Plugs, spark—service and/or replace .....	X			
Plugs, spark (two-piece)—repair .....		X		
Points, breaker, distributor—replace .....	X			
Pump assembly, fuel—replace and/or repair .....		X		
Pump assembly, fuel—rebuild .....			X	
Pump assembly, oil—replace and/or repair .....		X		
Pump assembly, oil—rebuild .....			X	
Pump assembly, water—replace .....	X			
Pump assembly, water—repair .....		X		
Pump assembly, water—rebuild .....			X	
Rods, connecting—replace .....		E	E	X
Thermostat—replace .....	X			
Valves—service .....		X		
Ventilator, crankcase—service and/or replace .....	X			
Wiring, ignition—replace .....	X			

## **EXHAUST GROUP**

Muffler and exhaust pipes—replace .....	X
-----------------------------------------	---

## **EXTINGUISHER, FIRE**

Extinguisher, fire (carbon tetrachloride $CCl_4$ ) service (refill) and/or replace .....	X			
Extinguisher, fire (carbon tetrachloride $CCl_4$ )—repair .....		X		
Extinguisher, fire (carbon tetrachloride $CCl_4$ )—rebuild .....			E	X

## **FUEL GROUP**

Filter assembly, fuel—service and/or replace .....	X			
Filter assembly, fuel—repair .....		X		
Lines and connections—replace .....	X			
Lines and connections—repair .....	E	X		
Pump assembly, primer—replace .....	X			
Pump assembly, primer—repair .....		X		
Pump assembly, primer—rebuild .....			X	
Tank—service and/or replace .....	X			
Tank—repair .....		X		

## **FINAL DRIVE**

Final drive assembly—replace .....	X			
Final drive assembly—repair .....		X		
Final drive assembly—rebuild .....			E	X
Hub assemblies—replace .....	X			

## INTRODUCTION

FINAL DRIVE (Cont'd)	ECHELONS			
	2nd	3rd	4th	5th
Hub assemblies—repair .....		X		
Hub assemblies—rebuild .....			E	X
Shaft, axle—replace .....	X			
Shaft, axle—repair .....		X		
Shaft, axle—rebuild (recondition) .....			E	X
Sprocket assembly, wheel—replace .....	X			
Sprocket assembly, wheel—repair .....		X		
Sprocket assembly, wheel—rebuild .....			E	X

## HULL

Hull—repair .....		X		
Hull—rebuild .....			E	X
Seat—replace .....	X			
Seat—repair .....		X		
Windshield assembly—replace .....	X			
Windshield assembly—repair .....		X		
Wiper assemblies, windshield—replace .....	X			
Wiper assemblies, windshield—repair .....	E	X		
Wiper assemblies, windshield—rebuild .....			X	

## INSTRUMENTS

Instruments—replace .....	X			
Instruments—repair .....		X		
Instruments—rebuild .....			E	X

## SHAFTS, PROPELLER

Shaft assemblies, propeller (w/universal joints)—replace .....	X			
Shaft assemblies, propeller (w/universal joints)—repair .....		X		
Shaft assemblies, propeller (w/universal joints)—rebuild .....			E	X

## SUSPENSION GROUP

Arm, idler rocker—replace .....	X			
Arm, idler rocker—repair .....		X		
Arm, idler rocker—rebuild .....			E	X
Axle assembly, rear—replace and/or repair .....		X		
Axle assembly, rear—rebuild .....			E	X
Bogie, components—replace .....	X			
Bogie, components—repair .....		X		
Bogie, components—rebuild .....			E	X
Bracket assemblies, bogie—replace and/or repair .....		X		
Bracket assemblies, bogie—rebuild .....			E	X
Roller, track supporting—replace .....	X			

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

SUSPENSION GROUP (Cont'd)	ECHELONS			
	2nd	3rd	4th	5th
Roller, track supporting—repair .....		X		
Roller, track supporting—rebuild .....			E	X
Track assemblies—replace .....	X			
Track assemblies—repair .....		X		
Track assemblies—rebuild .....			E	X
Wheel, bogie and idler—replace .....	X			
Wheel, bogie and idler—repair .....		X		
Wheel, bogie and idler—rebuild .....			E	X

**TRANSMISSION**

*Transmission assembly—replace .....	*	X		
Transmission assembly—repair .....		X		
Transmission assembly—rebuild .....			E	X

**VEHICLE ASSEMBLY**

Carrier, cargo—service .....	X			
Carrier, cargo—rebuild with serviceable unit assemblies			X	E

NOTE: Operations allocated will normally be performed in the echelon indicated by “X”.

Operations allocated to the echelons indicated by “E” may be accomplished by the respective echelons in emergencies only.

NOTE: \*The second echelon is authorized to remove and reinstall items marked by an asterisk. However, when it is necessary to replace an item marked by an asterisk with a new or rebuilt part, subassembly or unit assembly, the assembly marked by an asterisk may be removed from the vehicle by the second echelon *only after authority has been obtained from a higher echelon of maintenance.*



## CHAPTER 2

# TRANSMISSION AND PROPELLER SHAFT WITH UNIVERSAL JOINTS

### Section I

## TRANSMISSION

	Paragraph
Description and operation.....	4
Data .....	5
Trouble shooting .....	6
Removal of transmission.....	7
Cleaning and inspection .....	8
Disassembly of transmission.....	9
Cleaning, disassembly, inspection, repair, and assembly of transmission components .....	10
Assembly and test of transmission .....	11
Installation and test of transmission.....	12
Transmission controls and linkage.....	13

### 4. DESCRIPTION AND OPERATION (figs. 2 and 3).

a. The function of the transmission unit is to provide a means of transferring engine torque to the vehicle driving tracks at variable engine and track speed ratios. The several transmission gears, operating shafts, shifting mechanism, and bearings are contained in a cast-iron case having a lubricant filler plug and a drain plug. A cover plate is located on the top of the case, a mainshaft flange at the front, and a pinion flange at the rear. Two shift levers are mounted externally on the right side of the transmission case.

b. The transmission has three forward speeds and one reverse. Power enters at the rear end of the transmission through the transmission pinion from the clutch driven member, the hub of which is carried on the pinion shaft splines. The pinion is supported at its front end by a ball bearing, and at the rear by a bushing in the flywheel hub. Just inside the rear wall of the transmission case the power is transmitted to the transmission countershaft cluster gear. The cluster is carried on bronze bushings that bear on the countershaft, which is locked stationary in the case. The countershaft gear cluster and the transmission pinion are in motion at all times when the engine is operating and the clutch is engaged.

c. A splined mainshaft, a synchronizer unit, and a sliding gear, together with two shifting forks and mechanism, complete the transmission unit. The mainshaft is borne at its front end by a ball bearing, while the rear end turns on bearing rollers recessed in the forward end of the pinion. Movement of the synchronizer, or sliding gear, is con-

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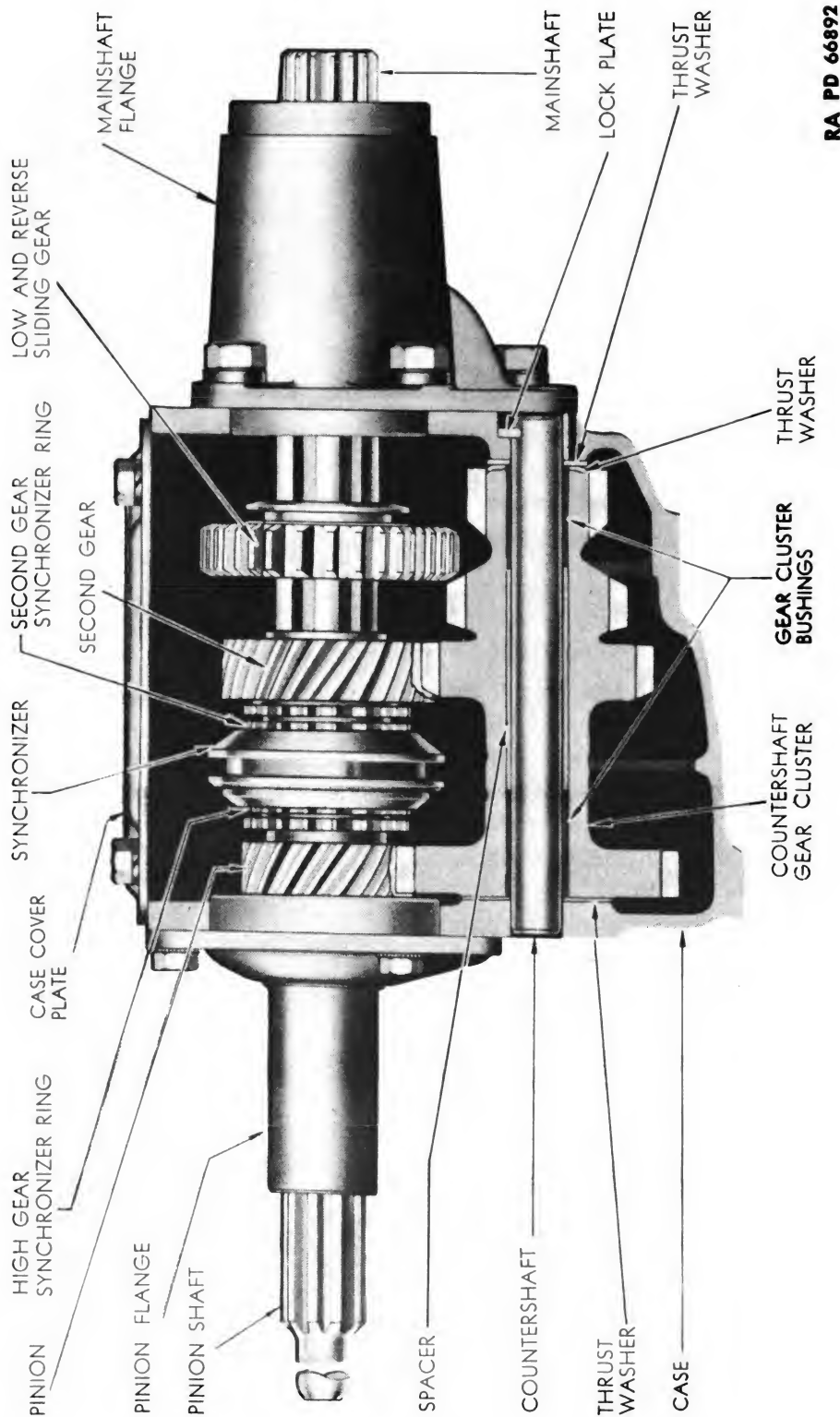
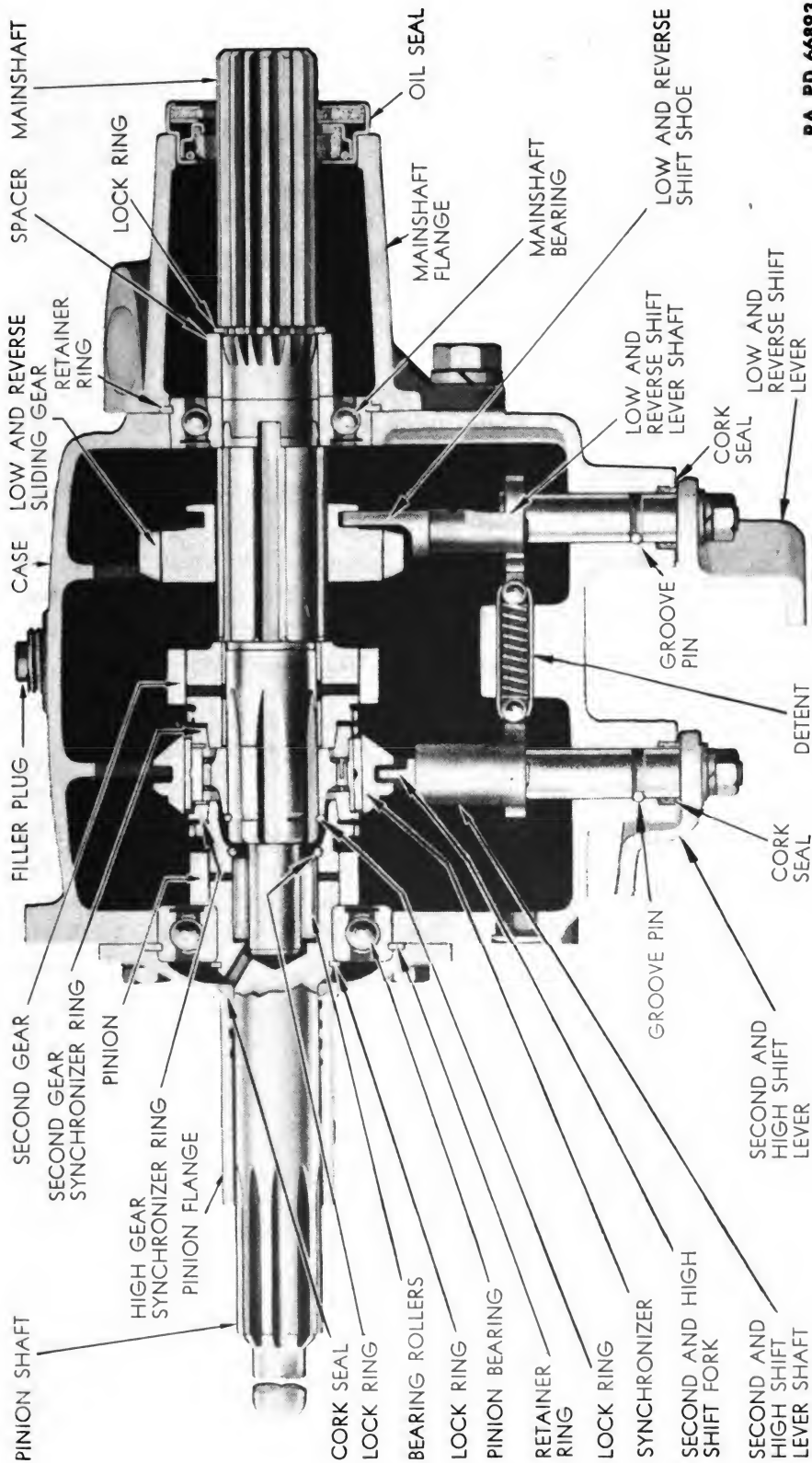


Figure 2—Transmission—Side Cut Away

# TRANSMISSION



RA PD 66893

Figure 3—Transmission—Top Cross Section

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

trolled by the transmission remote control shift lever located at the front of the cockpit immediately ahead of the driver's seat. The position of the synchronizer, or sliding gear, can be changed by moving the control lever and linkage to engage the first speed combination, second or third speed gearing, or the reverse gear combination. When the shift to high gear (third speed) is made, the synchronizer moves to the rear to engage the small spur teeth of the pinion. The drive through the countershaft gears is eliminated entirely in this position, because the mainshaft is connected directly with the engine clutch.

d. The second and high gear combination is fitted with synchronizing rings to permit shifting between second and high, or vice versa, without gear tooth interference. The reverse direction of motion is accomplished through an idler gear engaged with the small gear of the cluster. The sliding gear engages with the idler gear when a shift is made into reverse. The idler gear turns on a bronze bushing in its hub.

e. The splined forward end of the mainshaft is connected to the propeller shaft through a ground and splined sleeve, or slip joint with yoke, which is free to move ahead or rearward as required, due to the movement of the cushion-mounted engine. The outer ground surface of the slip joint bears against a spring-loaded leather seal to prevent the escape of oil at the forward end of the transmission case.

**5. DATA.**

Make .....	Warner
Model .....	T-84-J
Type .....	Synchromesh
Speeds .....	3 forward, 1 reverse
Helical gears .....	2nd speed and constant mesh
Synchronizers .....	2nd and high

**Ratios:**

1st .....	2.66
2nd .....	1.56
3rd .....	1 to 1
Reverse .....	3.55

**Pinion bearing:**

Type .....	Ball
Manufacturer's number .....	MRC-207SFG or SKF-6207-ZN
Bore .....	1.3775 in.
Outside diam .....	2.8340 in.
Width .....	0.6643 in.

**Mainshaft front bearing:**

Type .....	Ball
Manufacturer's number .....	MRC-207SFG or SKF-6206-ZN
Bore .....	1.1807 in.
Outside diam .....	2.4403 in.
Width .....	0.6250 in.

**TRANSMISSION**

Mainshaft bearing rollers:

Type .....	Needle
Diameter .....	0.1875
Length .....	0.5270

**6. TROUBLE SHOOTING.****a. Noisy in Neutral.**

<b>Possible Cause</b>	<b>Possible Remedy</b>
Misalignment of transmission with engine assembly.	Aline clutch housing to engine front plate and aline transmission to clutch housing.
Transmission pinion bearing rough, damaged, or dirty.	Clean or replace as required.
Transmission constant mesh gears scuffed, chipped, burred, or improperly machined.	Replace as required.
Transmission countershaft bushings scored, dirty, or rough.	Clean or replace as required.
Transmission mainshaft second speed gear bushing rough, scored, or damaged.	Clean or replace mainshaft with gears assembly.
Transmission constant mesh gears not properly meshed.	Replace with a complete set of gears.
Reverse idler gear shaft or bushing rough, scored, or damaged.	Replace as required.
Reverse idler gear, scuffed, chipped, burred, or improperly machined.	Replace.
Eccentric second speed constant mesh gear.	Replace mainshaft with gears assembly.
Too much lash in constant mesh gear train.	Replace worn or damaged parts.
Abnormal end play of countershaft gear cluster, reverse idler gear, or pinion.	Replace defective parts.
Transmission mainshaft pilot bearing rollers badly damaged or broken.	Replace.
Insufficient lubricant in transmission.	Fill to recommended level.
Incorrect grade, or dirty transmission lubricant.	Drain, flush transmission, and replace lubricant.

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**b. Noisy in Gear.**

Possible Cause	Possible Remedy
Transmission mainshaft front bearing rough, damaged, or dirty.	Clean or replace as required.
Transmission sliding gear teeth rough, burred, scuffed, pitted, chipped, or tapered.	Replace mainshaft with gears assembly.
Excessive clearance or end play of mainshaft second speed gear on mainshaft.	Replace mainshaft with gears assembly.

**c. Oil Leaks.**

Lubricant level too high in transmission case.	Drain to proper level.
Damaged, improperly installed, or missing gaskets.	Replace or install as required.
Damaged or improperly installed oil seals.	Replace or reinstall as required.
Transmission case drain or filler plug loose, or threads damaged.	Tighten or replace plug as necessary.
Transmission case bolts loose, missing, or threads stripped.	Tighten or replace bolts.
Sand hole or crack in transmission case.	Replace transmission case.
Use of lubricant which foams excessively.	Drain, flush, and refill transmission with recommended lubricant.

**d. Difficult to Shift into Gear.**

Failure to completely disengage clutch.	Inspect clutch pedal and linkage for freedom and maximum travel, or correct faulty shifting habit.
Synchronizer sleeve fits too tightly on synchronizer gear.	Replace synchronizer assembly.
Insufficient chamfer on sliding gear teeth.	Replace mainshaft with gears assembly.
Mainshaft splines distorted, burred, or damaged.	Replace mainshaft assembly.
Sliding gear tight on mainshaft splines.	Free members or replace mainshaft with gears assembly as required.
Improperly adjusted or bent remote control linkage.	Adjust, straighten, or replace as required.

## TRANSMISSION

### e. Sticks in Gear.

Possible Cause	Possible Remedy
Engine clutch not completely disengaged.	Check clutch adjustment and release mechanism.
Insufficient chamfer at edge of gearshift lever cam poppet ball notches.	Replace parts as required.
Sliding gear tight on mainshaft.	Free or replace mainshaft with gears assembly.
Distorted, burred, or damaged mainshaft splines.	Replace mainshaft with gears assembly.
Improperly adjusted or bent remote control linkage.	Adjust, straighten, or replace as required.

### f. Slips Out of High Gear.

Misalignment of transmission with engine.	Align clutch housing to engine front plate, and transmission to clutch housing as required.
Transmission pinion gear teeth tapered.	Replace pinion.
Synchronizer sleeve to ring teeth damaged or tapered.	Replace synchronizer assembly.
Insufficient poppet spring tension on gearshift lever cam notch.	Replace poppet.
Excessive chamfer on edge of gearshift lever cam notch.	Replace shift lever.
Improperly adjusted or bent remote control linkage.	Adjust, straighten, or replace parts involved.

### g. Slips Out of Second Gear.

Abnormal end play of second speed constant mesh gear on mainshaft.	Replace parts as required.
Synchronizer sleeve or ring teeth tapered or distorted.	Replace synchronizer assembly.
Excessive chamfer on edge of gearshift lever cam notch.	Replace shift lever.
Improperly adjusted or bent remote control rods.	Adjust, straighten, or replace parts involved.

### h. Slips Out of First and Reverse Gear.

First and reverse sliding gear loose on mainshaft splines.	Replace mainshaft with gears assembly.
------------------------------------------------------------	----------------------------------------

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Possible Cause	Possible Remedy
First and reverse sliding gear teeth damaged or tapered.	Replace mainshaft with gears assembly.
Mainshaft splines distorted.	Replace mainshaft with gears assembly.
Countershaft first speed gear teeth damaged or tapered.	Replace gear cluster.
Excessive end play of countershaft gear cluster.	Replace worn or damaged parts.
Reverse idler gear teeth damaged or tapered.	Replace gear.
Excessive end play of reverse idler gear in transmission case.	Replace defective parts.
Too much chamfer on edge of gearshift lever cam notch.	Replace shift lever.
Gearshift lever cam notch not machined sufficiently deep.	Replace shift lever.
Improperly adjusted or bent remote control rods.	Adjust, straighten, or replace parts involved.
Transmission locks in two gears at once.	See "Note" (below).

i. **Diagnosis.** Most noises emanating from the transmission will not be audible with the vehicle in motion because of the various other operating noises. However, a preliminary operating check on the transmission may be obtained by first disengaging the axle transmission (place the shift lever in neutral). With the engine running, shift the transmission into low, second, high, and reverse gears respectively. In each position, run the engine at various speeds, and listen carefully for unusual noises. It is possible that the investigation will disclose a noise caused by another part of the drive line; such as from worn universal joint needle bearings, loose universal joints, a bent or otherwise misaligned propeller shaft, or a faulty clutch.

## **7. REMOVAL OF TRANSMISSION.**

- a. **Remove Top and Bows.** Refer to paragraph 66.
- b. **Remove Seats.** Refer to paragraph 67.
- c. **Remove Propeller Shaft.** Refer to paragraph 16.
- d. **Disconnect Transmission.** Remove the two screws that secure the transmission support cushion to the pad on the floor of the hull.

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Note: Where operating difficulties involve the remote control shift rods and linkage, the adjustment and rate of wear on the engine mountings affect the relative position of the engine to permit movement which may change the control linkage adjustment.



## TRANSMISSION

Disconnect the remote control linkage at the transmission by removing the two cotter pins and clevis pins.

e. **Remove Engine Compartment Front Lid Screen.** Refer to paragraph 68.



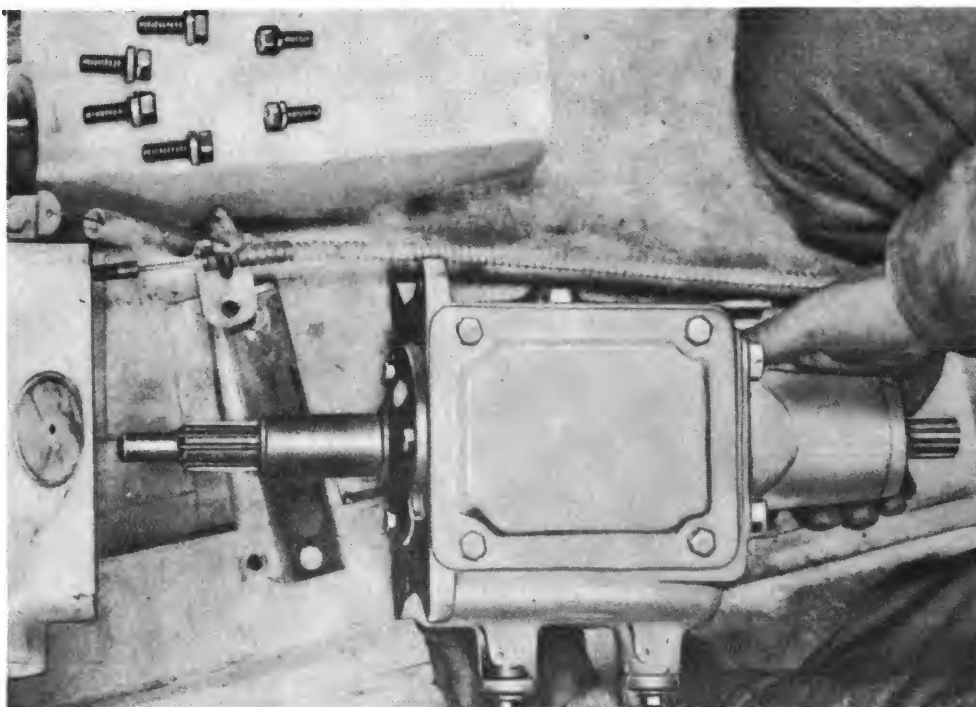
ENGINE LIFTING EYE BOLT 41-B-1586-10

RA PD 49413

**Figure 4—Supporting Front of Engine**

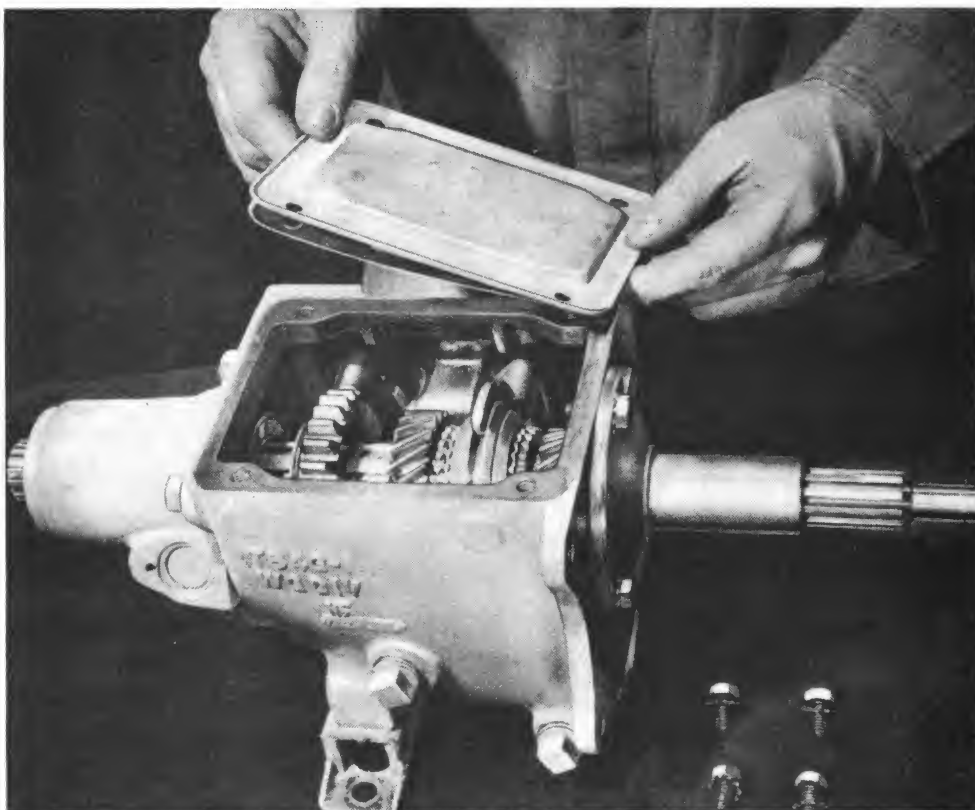
f. **Install Engine Lifting Eyebolt.** Remove the hull drain plate and drain the cooling system sufficiently to bring the solution level below the top of the cylinder head. Remove the cylinder head screw between the front two spark plugs, and install engine lifting eyebolt (41-B-1586-10).

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RA PD 58280

**Figure 5—Removing Transmission**



RA PD 49414

**Figure 6—Removing Transmission Case Cover**

## TRANSMISSION

**g. Support Front of Engine.** Attach a hoist lifting chain to the eyebolt, and operate the hoist to raise and support the front end of the engine. (In an emergency, a wood block may be used under the Bendix drive cover to support the engine.)

**h. Remove Transmission.** Remove the four cap screws and lock washers which secure the transmission to the clutch housing. While supporting the transmission assembly with the hands, move the unit forward until the rear end of the transmission pinion has cleared the clutch housing (fig. 5). Lift the transmission out of the cockpit. Note that a shim is used between the support cushion and the pad on the floor of the hull.



RA PD 49415

**Figure 7—Removing Pinion Flange**

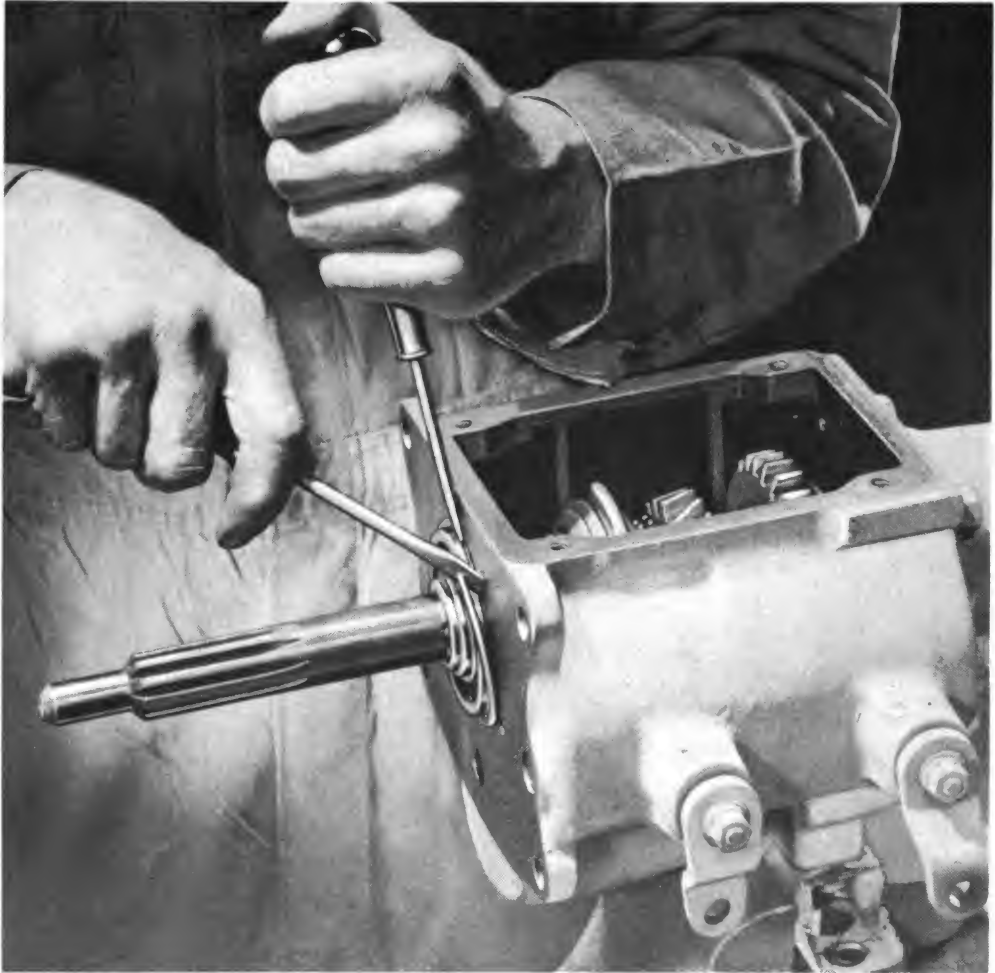
## 8. CLEANING AND INSPECTION.

**a. Cleaning.** Apply dry-cleaning solvent with a brush or cloth to soak off any lubricant, dirt, or foreign matter that may have accumulated on the exterior of the case and flanges. Dry all surfaces with wiping cloths, or by using compressed air.

**b. Inspection.** Remove the transmission case drain plug, and drain out the lubricant. Inspect carefully, the outside of the transmission case, pinion flange, and mainshaft flange to detect cracks, oil seepage,

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or any external damage. Remove the four transmission case cover cap screws and toothed lock washers, and lift the cover and gasket off the case (fig. 6). Inspect the internal transmission parts to detect any evidence of damaged gears, shafts, synchronizer, or shifting mechanism.



RA PD 49416

**Figure 8—Removing Pinion Bearing Retainer Ring**

**9. DISASSEMBLY OF TRANSMISSION.**

a. **Remove Pinion Bearing.** Place transmission assembly in a vise and remove the three pinion flange screws and toothed lock washers. Slip pinion flange and gasket off pinion shaft (fig. 7). Slide cork seal off pinion shaft. Remove the pinion bearing large retainer ring (fig. 8). Remove the pinion bearing small lock ring, using snap ring pliers (fig. 9). Install a bearing puller similar to that shown in figure 10. Pull pinion bearing out of case and off pinion shaft. Be careful not to damage synchronizer rings.

## TRANSMISSION



RA PD 49418

**Figure 9—Removing Pinion Bearing Lock Ring**



RA PD 49417

**Figure 10—Removing Pinion Bearing**



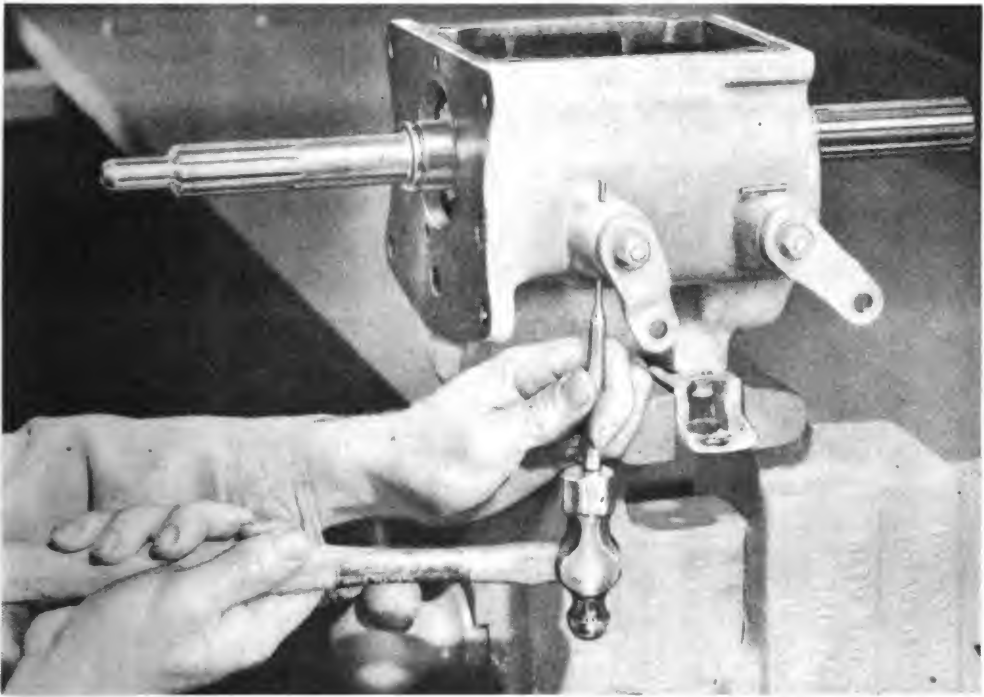
**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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SYNCHRONIZER PROTECTOR 41-P-2839-725

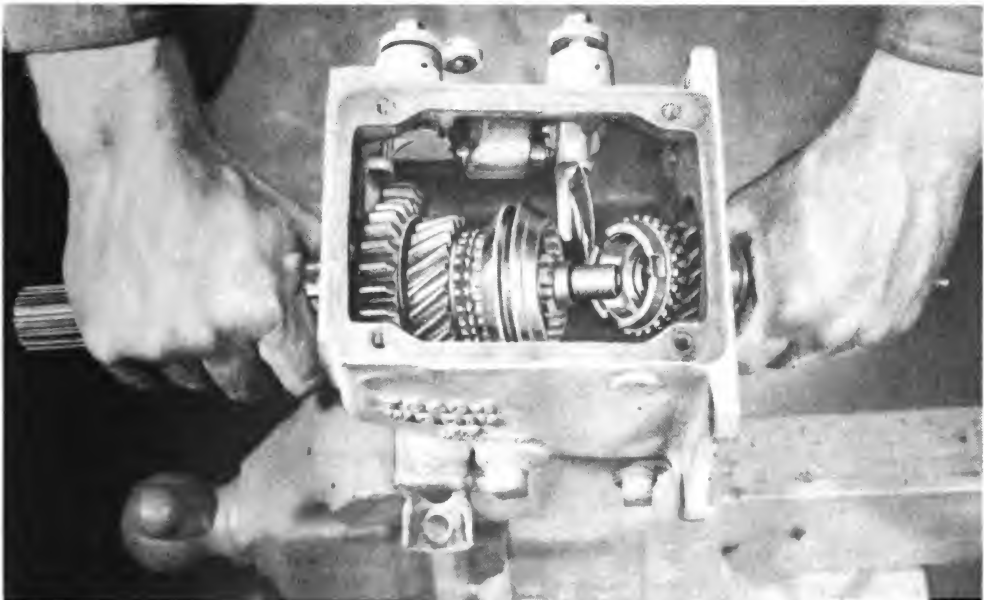


RA PD 49420

**Figure 11—Initial Removal of Mainshaft Rear Bearing**

**TRANSMISSION**

RA PD 49421

**Figure 12—Removing Shift Lever Shaft Pins**

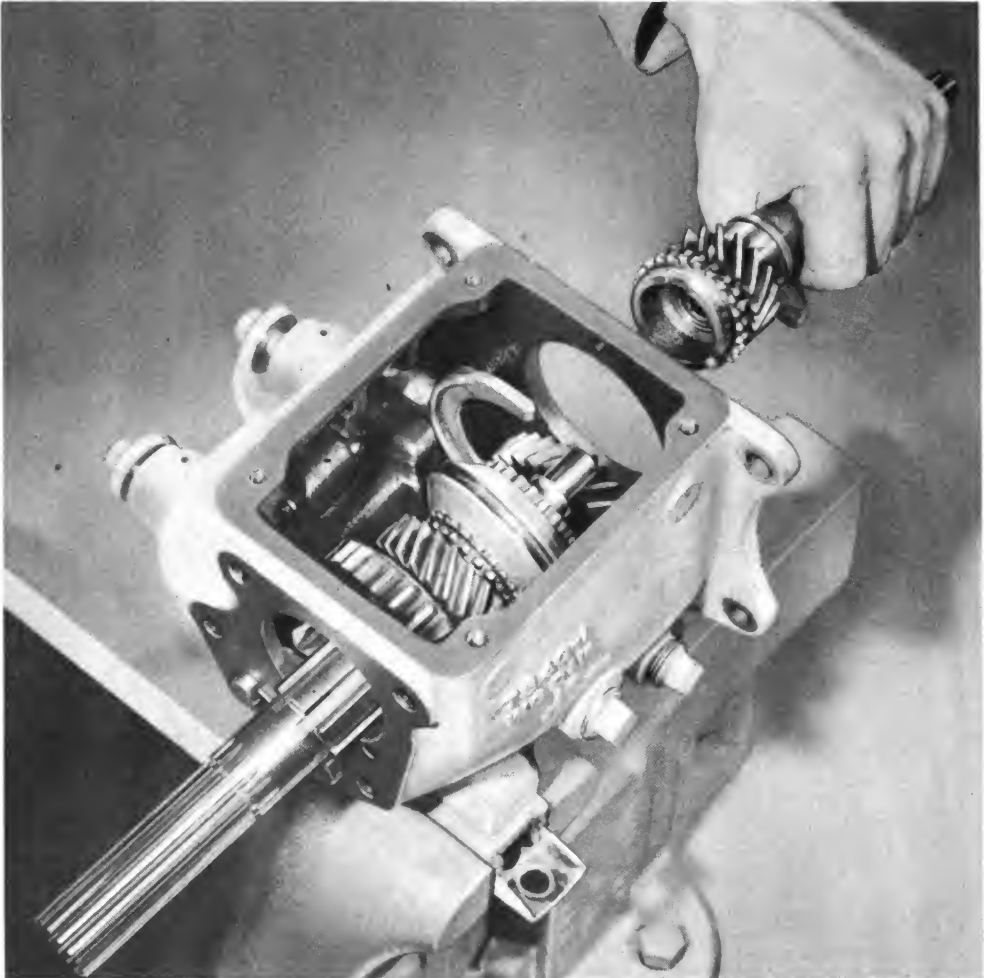
RA PD 49441

**Figure 13—Separating Pinion and Mainshaft Assemblies**

b. **Remove Mainshaft Bearing.** Take out the four screws with toothed lock washers that hold mainshaft flange to transmission case, and remove flange and gasket. (The lowest screw is longer than the

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others.) Remove spacer lock ring with snap ring pliers, slip spacer off mainshaft, and remove mainshaft front bearing retainer ring. Carefully pry in the bearing retainer ring groove to move mainshaft front bearing out of case sufficiently to permit installation of bearing puller equipment (fig. 11), and pull the bearing off the mainshaft.

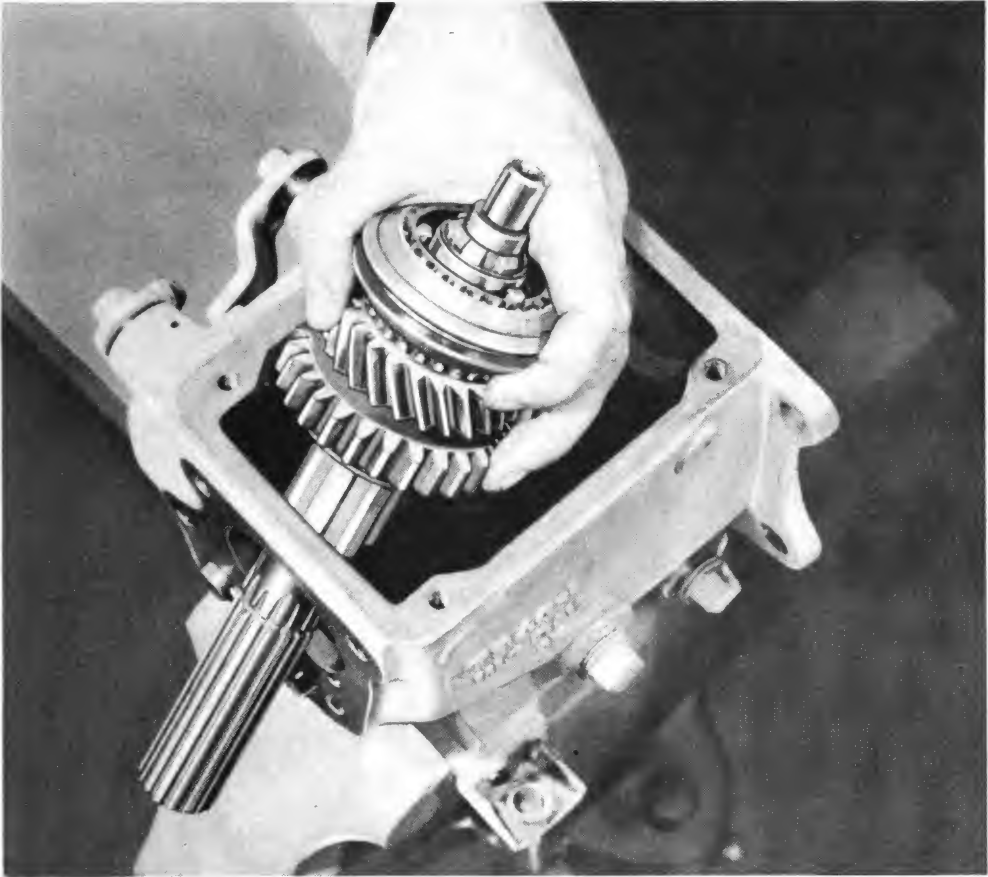


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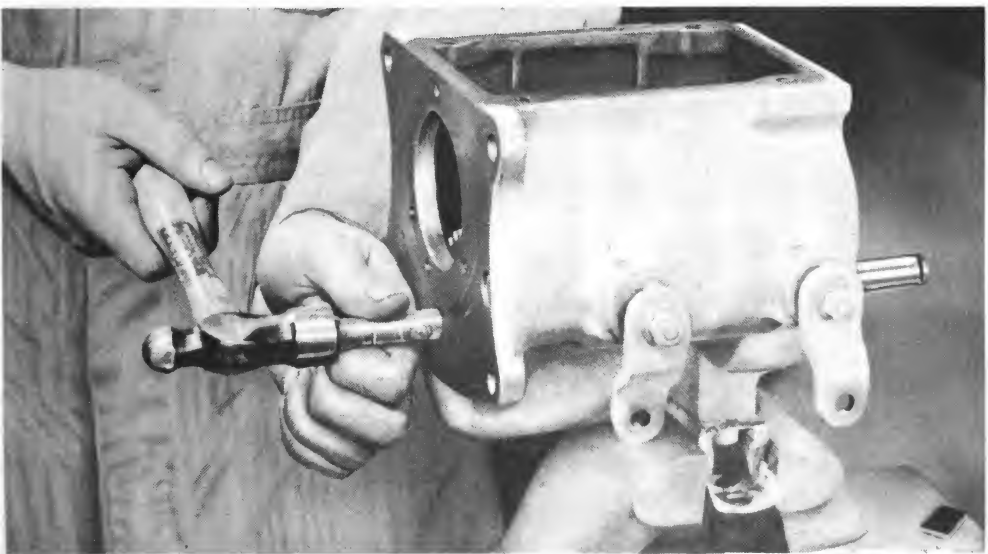
**Figure 14—Removing Pinion Assembly**

c. **Remove Pinion and Mainshaft with Gears.** Drive out from below, the retaining pin at each shift lever shaft (fig. 12). Pull the two shift lever shafts outward as far as possible. Move pinion and mainshaft with gears away from shift fork and shoe, and move the shift fork and shoe out of the way. Tilt mainshaft slightly, and pull pinion shaft away from the end of mainshaft (fig. 13), and out rear of case (fig. 14). Lift mainshaft with gears and synchronizer upward and out through top of case (fig. 15). Remove shift fork and shoe from shift lever shafts.



**TRANSMISSION**

RA PD 49423

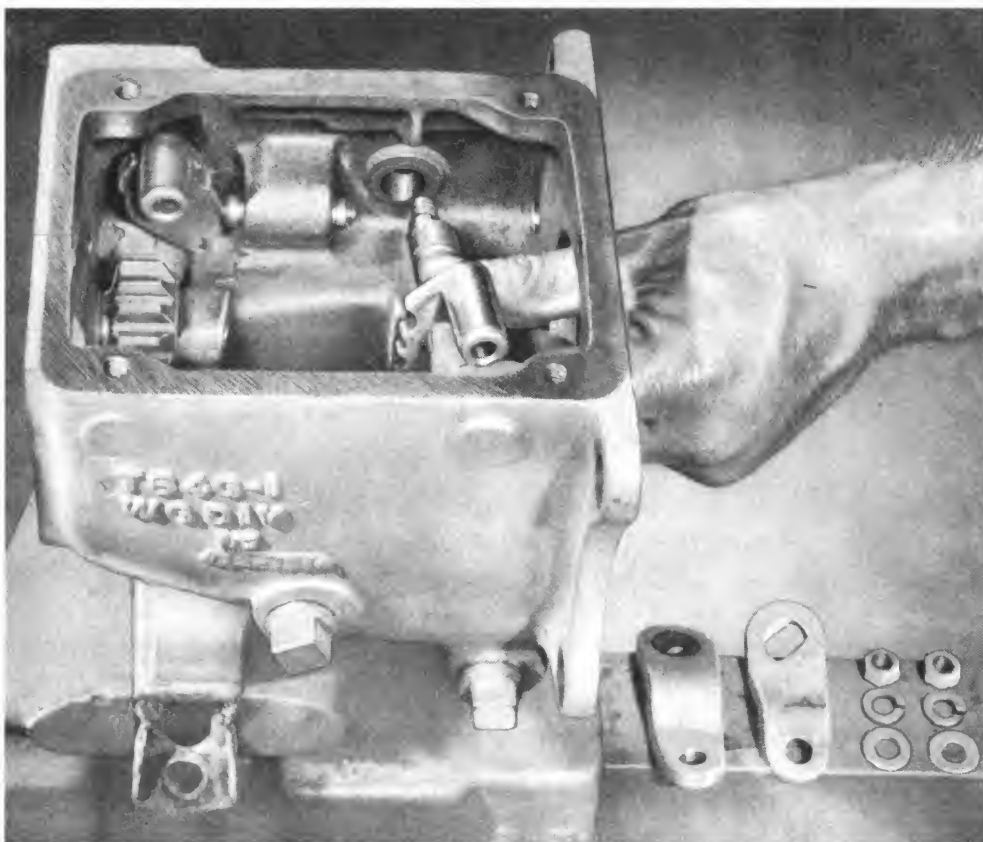
**Figure 15—Removing Mainshaft Assembly**

RA PD 49424

**Figure 16—Removing Countershaft**

# **ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

d. **Remove Countershaft and Gear Cluster.** Remove the countershaft and reverse idler gear shaft lock plate. Drive countershaft out front of transmission case (fig. 16). Lift the cluster gear out through top of case. Note that thrust washer at rear of gear cluster (largest gear) has an ear which must be toward the case so that washer will not turn with cluster. Two thrust washers are used at other end cluster. The washer with the small hole must be next to case so that small hole will fit over pin in case to hold it stationary. Between this front thrust washer and the cluster is a thrust washer with ears that engage between the teeth of the small gear at the front so that it turns with the cluster.



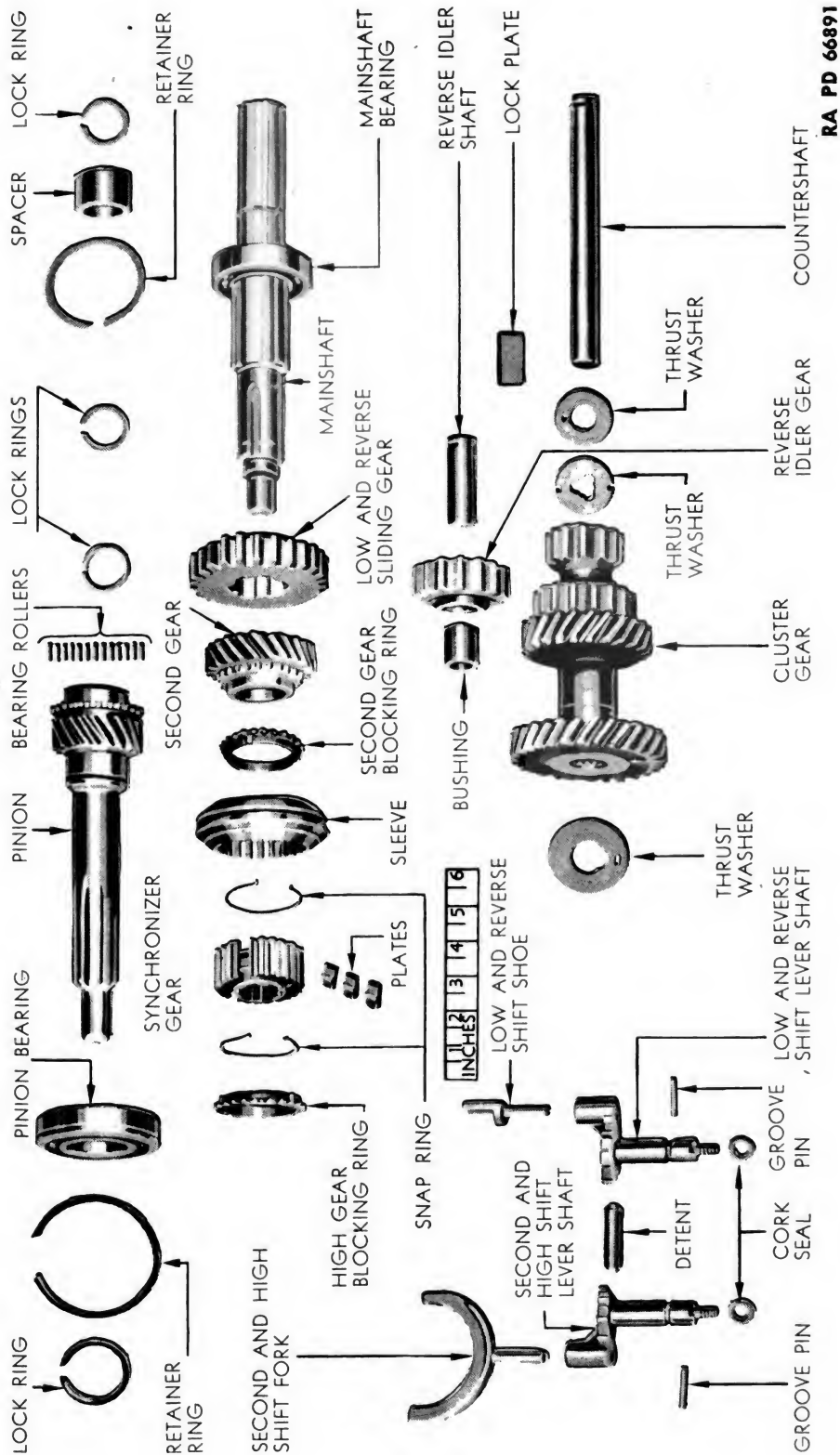
RA PD 49442

**Figure 17—Removing Shift Lever Shaft**

e. **Remove Reverse Idler Gear Shaft and Gear.** Remove reverse idler gear shaft from transmission case, driving on the rear end of shaft if necessary. The reverse idler gear may be lifted out of case as shaft is removed. Note that gear hub extension is toward the rear.

f. **Remove Shift Levers and Shafts.** Remove the nut, lock washer, and flat washer that hold outer shift lever to shift shaft. Remove outer shift lever and cork seal; lift shift shaft out of hole in side of the case, and out top of transmission case (fig. 17). Remove the shift lever poppet •

## TRANSMISSION



**Figure 18—Transmission Gears, Shafts, Bearings, and Shifter Details**

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from recess in side of case. Repeat the operations to remove the other shift lever and shaft.

g. **Remove Engine Front Mounting from Transmission Case.** Remove the two cap screws and lock washers that hold the flexible engine front mounting with bracket to bottom of transmission.

**10. CLEANING, DISASSEMBLY, INSPECTION, REPAIR, AND ASSEMBLY OF TRANSMISSION COMPONENTS.**

a. **General.** The disassembly, cleaning, inspection, repair, and assembling of the various subassemblies must be performed with care and



RA PD 49425

**Figure 19—Removing Pinion Bearing Rollers Lock Ring**

cleanliness. To avoid confusion or error, each subassembly must be treated as a unit. Mark certain related parts before disassembly to aid in subsequent assembly operations. Carefully clean each component after disassembly. The various parts must be inspected carefully and thoroughly to determine their fitness for further service.



**TRANSMISSION**

b. **Cleaning.** Clean all parts and subassemblies carefully in dry-cleaning solvent. Blow them dry with compressed air, being careful to direct the air at the side or face of the bearings to avoid spinning.



RA PD 49439

**Figure 20—Removing Synchronizer, Second Speed Gear, and Low and Reverse Sliding Gear**

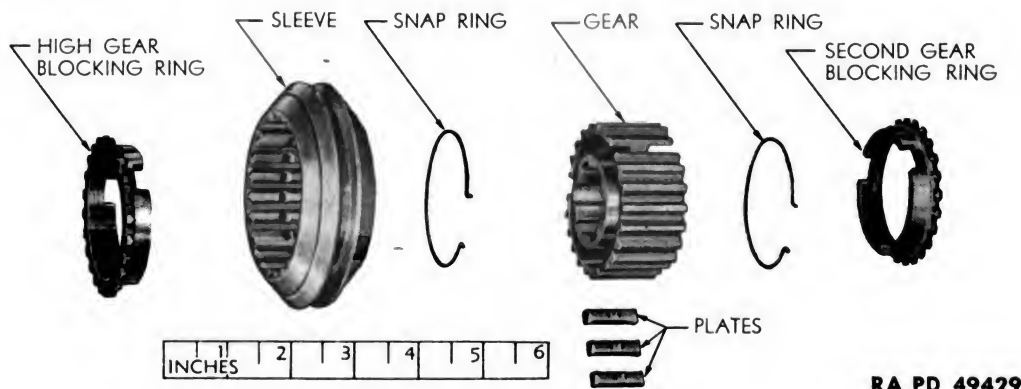
c. **Pinion and Bearings.**

(1) **DISASSEMBLY.** Lift synchronizer ring off gear end of pinion. Hold pinion assembly in a vise having copper or other soft metal inserts for the jaws: Remove the bearing rollers lock ring from groove in pinion

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recess, using a thin narrow-blade screwdriver and a 4-inch blade screwdriver (fig. 19). Remove the 13 bearing rollers.

(2) **INSPECTION AND REPAIR.** Clean all parts in dry-cleaning solvent. Inspect the ball bearing and bearing rollers for galling or damage. Inspect the pinion helical gear teeth for evidence of damage. Examine splines on pinion shaft for damage. Inspect the high speed gear teeth for chipping. If extensive damage is evident to gear teeth or shaft splines, a new pinion must be installed, unless any burs or damage can be eliminated by stoning. Replace the ball bearing and bearing rollers if damaged.



**Figure 21—Synchronizer Parts**

(3) **ASSEMBLY.** With pinion held in a vise having copper or other soft metal inserts for the jaws, place the 13 bearing rollers around the wall of recess in pinion, using grease to hold rollers in position. Insert the bearing rollers retainer ring in its groove in pinion recess, using a thin narrow-blade screwdriver. Place synchronizer ring in position over inner end of pinion with teeth next to the high gear teeth on pinion. (If high gear and second speed gear synchronizer rings are placed in a cleaning tank together, it is important that each ring be marked in some way to assure its installation at the same location as before disassembly.)

**d. Mainshaft and Parts.**

(1) **DISASSEMBLY.** Fasten mainshaft with gears and synchronizer in a vise having copper or other soft metal jaws. Remove lock ring from rear end of mainshaft, using snap ring pliers. Slide the synchronizer gear and sleeve assembly off the end of the mainshaft. Note that the synchronizer sleeve side having a circular marking groove is installed toward the rear (pinion) end of the mainshaft. Slip the second speed gear synchronizer ring off end of mainshaft. Slide the second speed gear, and low and reverse sliding gear off end of mainshaft (fig. 20). Note that short hub of second speed gear is installed next to low and reverse sliding gear, and the flat face of the low and reverse sliding gear

## TRANSMISSION

is toward the second speed gear. Slip the synchronizer sleeve off synchronizer gear. The three synchronizer shoe plates will fall off the gear, as will snap rings on sides of gear (fig. 21).

(2) **INSPECTION AND REPAIR.** Clean all the parts in dry-cleaning solvent, and wipe them thoroughly. Examine the teeth on the gears for chipping or damage. Inspect the bushing in the second speed gear. If the bushing is damaged, a new gear with bushing must be installed.



RA PD 49426

**Figure 22—Installing Synchronizer Hub Lock Ring**

Inspect the mainshaft and ball bearing for scores or damage. If necessary, dress with a fine stone any rough portions on the gears or shaft. Replace with new parts any damaged items which are available separately, or install a new mainshaft with gear assembly.

(3) **ASSEMBLY.** Apply SAE 10 engine oil to the parts before, or while, assembling the components to the mainshaft. Install both shoe plate snap rings in the synchronizer gear, and install the three shoe plates in position on the gear. While holding the shoe plates in place with one hand, slip the synchronizer sleeve over the gear and shoes.

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Make certain that the sleeve is installed, so that the circular marking groove is on the same side of the gear which has the hub practically flush with the end of the gear teeth. Fasten mainshaft in vise having copper or other soft metal inserts for the jaws. Slip the first and reverse sliding gear over large splines on mainshaft, noting that the side of the gear having the shift shoe groove goes on first. Slide the second speed gear over end of mainshaft, noting that the side with the small teeth goes on last. Install the second speed gear synchronizer ring with its teeth nearest the second speed gear small spur teeth. Install the synchronizer assembly. (The circular marking groove in the side of the



RA PD 67271

**Figure 23—Installing Mainshaft Flange Oil Seal**

sleeve must be toward the pinion.) Using snap ring pliers, install lock ring in groove near end of mainshaft (fig. 22).

## **e. Countershaft and Gear Cluster.**

(1) **DISASSEMBLY.** Remove the bushing from each end of the gear cluster bore and the spacer between the bushings. (These parts are a slip fit in the cluster bore.)

(2) **INSPECTION AND REPAIR.** Clean the parts in dry-cleaning solvent. Wipe the parts with a clean cloth and examine the teeth on the gears for chipping or other damage. Remove any burs or nicks by stoning. Inspect the bushings and countershaft; if they are damaged, replace parts as required.



## TRANSMISSION

(3) **ASSEMBLY.** Install the two bushings with the spacer between them in the bore of the gear cluster.

f. **Reverse Idler Gear and Shaft.** Clean the parts in dry-cleaning solvent. Determine by inspection whether the gear teeth, bushing, and shaft are damaged. If the gear, bushing, or shaft is damaged, replace as required. Make sure the gear turns freely on the shaft.

g. **Shifting Mechanism.** Clean the parts in dry-cleaning solvent and dry with a clean cloth. Inspect the inner levers and shafts, fork, and shoe for damage. Replace any parts found to be damaged and unfit for further service.



RA PD 49440

**Figure 24—Installing Reverse Idler Gear and Shaft**

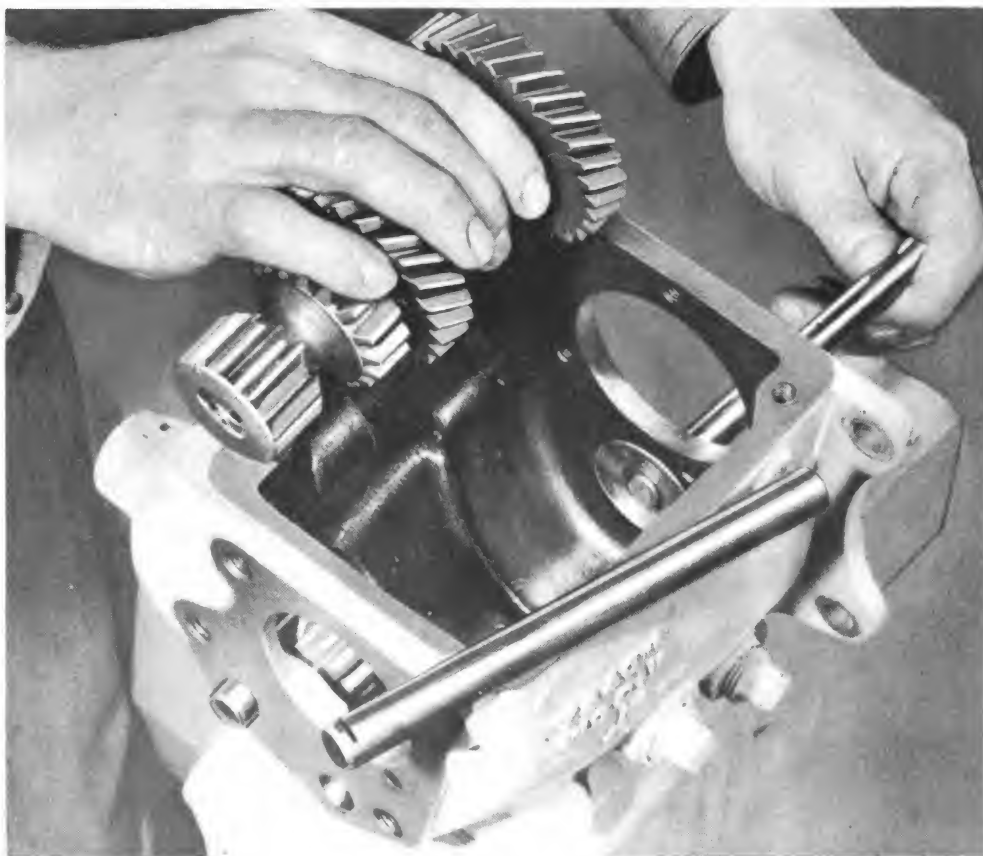
h. **Engine Front Mounting.** Clean the metal portion of this part with a putty knife and wiping cloth. Inspect the metal portion of the mounting for cracks. Check the rubber cushion to determine if it has deteriorated from oil soaking into the rubber. If the mounting is unfit for further service, replace it.

i. **Case and Flanges.** Inspect the inside of the case for damage. Examine the case rear flange (pinion end) for damage, and the extension for grooves. Check the case front flange for damage, and make sure that the oil seal contacts the transmission slip joint outer machined surface. Install a new oil seal and replace any other damaged parts (fig. 25).

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****11. ASSEMBLY AND TEST OF TRANSMISSION.****a. Assembly.**

(1) **INSTALL ENGINE FRONT MOUNTING ON TRANSMISSION CASE.** Install the engine front mounting with bracket on the case pad. Tighten the two cap screws and lock washers.

(2) **INSTALL SHIFT LEVERS AND SHAFTS.** Place the transmission case in a vise and install the front (low and reverse) shift lever and shaft from top of transmission, noting that poppet cam must be toward



RA PD 49428

**Figure 25—Installing Countershaft Gear Cluster and Shaft**

poppet recess and shift shoe shaft bore toward the top. Install a new cork seal over end of shift shaft. Place the outer shift lever (short) on end of shaft with clevis pin hole toward bottom and away from case. Install the shaft flat washer, lock washer, and nut; and tighten the nut securely. Install the poppet in recess within case. Repeat the installation procedure to install the second and high shift lever and shaft with related parts. Make sure the outer shift lever (long) is installed with clevis pin eye toward the bottom, and bend in lever toward the case.

### TRANSMISSION

(3) **INSTALL REVERSE IDLER GEAR AND SHAFT.** Place gear in case with gear hub extension toward rear (fig. 24). Slip shaft into case and through gear until lock groove in shaft remains slightly out of case.

(4) **INSTALL COUNTERSHAFT GEAR CLUSTER AND SHAFT.** Install the front thrust washer so that small hole in washer fits over pin in case. Use grease to hold the washer in position. Install the other front thrust



RA PD 49430

**Figure 26—Installing Pinion and Mainshaft Assemblies**

washer at the small gear end of the cluster so that the ears fit between the gear teeth. Install the rear thrust washer against the case, using grease to hold the washer with its ear next to the case. Carefully lower gear cluster into position (largest gear toward the rear) so that shaft bores in case are in line with cluster bore. Use a dummy shaft at the rear end to maintain the cluster in position while inserting the counter-

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shaft into the case and cluster bores from the front (fig. 25). Tap countershaft in until shaft lock groove remains slightly out of case. Install countershaft and reverse idler gear shaft lock plate, then tap locked ends of shafts to make sure shafts are located properly, and lock plate is secure.

(5) **INSTALL MAINSHAFT WITH GEARS AND PINION.** Insert shift fork and shoe in their respective shift levers, and move the fork and shoe, as close as possible to ends of case. Install the mainshaft with



RA PD 49431

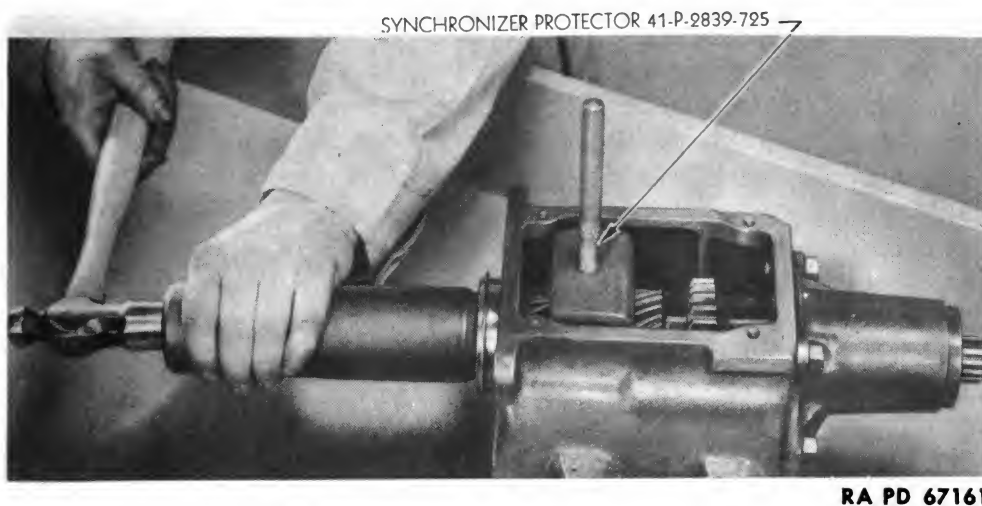
**Figure 27—Engaging Poppet**

gears, and synchronizer by lowering the end with small splines down through opening in top of case, and out the bore in front (fig. 26). Place SAE 10 engine oil on rear end of mainshaft where it revolves on bearing rollers recessed in pinion. Place pinion assembly into rear opening of case and over rear end of mainshaft. Roll the two connected shafts with gears against side of case opposite the shifting parts, and aline the shift fork and shoe with their operating grooves. Move shaft and pinion toward center so that shifting fork and shoe engage in their respective operating grooves.

## TRANSMISSION

(6) **INSTALL MAINSHAFT BEARING.** Coat the bearing with SAE 10 engine oil. Install bearing over end of shaft with lock ring groove toward outside of case. Install thrust yoke with thin side of yoke in pinion gear groove. Use a section of tubing or pipe (1¼-in. inside diameter) and a soft metal hammer to drive the tube against bearing inner race when installing the bearing into its proper location. Hold the pinion with one hand in order to provide thrust while driving the mainshaft bearing into place. Install the large retainer ring. Tap the tubing with soft metal hammer to make sure the bearing retainer ring is against the transmission case. Slip spacer over end of shaft and install the small lock ring, using snap ring pliers.

(7) **INSTALL MAINSHAFT FLANGE.** Install mainshaft flange and a new gasket on front end of case, using four cap screws and toothed lock



**Figure 28—Installing Pinion Bearing**

washers. Make sure screw threads are coated with white lead paste, and that the longest screw is installed in the lowest hole.

(8) **ENGAGE POPPET WITH SHIFT LEVER CAMS.** Push one shift lever and shaft so that middle notch on cam engages with ball at one end of poppet. Then depress the other poppet ball at the free end of the poppet and move the other shift lever and shaft, so that middle notch on cam engages the poppet ball (fig. 27). Install the lever shaft retaining pin.

(9) **INSTALL PINION BEARING.** With the synchronizer protector (41-P-2839-725) in position, install pinion bearing over the end of the pinion shaft, with the ring groove in the bearing toward the outside. Drive the bearing into place in the end of the base (fig. 28). Install the pinion bearing small lock ring, using snap ring pliers. Install the pinion bearing large retainer ring. Remove the synchronizer protector. Install a new cork seal over the end of the pinion shaft against the bearing.



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Install a new gasket and the pinion flange. Install the three cap screws and toothed lock washers, using white lead paste on the screw threads.

**b. Test.** Test the transmission for free rotation and proper operation of the shifting mechanism by turning the pinion shaft with the hand, and shifting into the different gear positions by moving the external levers. Place one pint of SAE 10 engine oil in the case before cover is installed. Install case cover with four screws and toothed lock washers. Install a dummy transmission slip joint, or pack rags between the main-shaft and oil seal to prevent loss of lubricant when the transmission is installed.

**12. INSTALLATION AND TEST OF TRANSMISSION.****a. Install Transmission.**

(1) **INSTALL AND SECURE TRANSMISSION TO CLUTCH HOUSING.** Before installing the transmission assembly, operate the low and reverse outer shift lever to engage the low and reverse sliding gear. Lift the transmission assembly with the hands, and carefully insert end of pinion through clutch housing bore and clutch release bearing. Then as pinion splines approach the clutch driven member splines, turn the transmission dummy slip joint to the right or left, so the two sets of splines will match. Continue moving the assembly rearward until rear end of pinion enters the clutch pilot bushing and transmission case is against clutch housing forward face. Install the four cap screws with lock washers, and tighten them securely.

(2) **CONNECT TRANSMISSION.** With the shim in place between the support mounting and the pad on floor of hull, install the two screws, making sure that clutch control cable conduit bracket is in place under screw head on left side. Lower engine and tighten support mounting screws securely. Connect remote control linkage to outer shift levers with clevis pins and new cotter pins. Apply SAE 10 engine oil to linkage.

(3) **REMOVE ENGINE LIFTING EYEBOLT.** Remove the hoist lifting chain and eyebolt. Coat threads of cylinder head screw with white lead paste, and tighten properly (600 to 650 in.-lb) with tension wrench. Reinstall the cooling system solution, and check for leakage. Coat hull drain plate screws, hull drain plate, and new gasket with joint and thread compound. Install plate and gasket, and tighten screws securely.

(4) **INSTALL ENGINE COMPARTMENT FRONT LID SCREEN.** Refer to paragraph 68.

(5) **INSTALL PROPELLER SHAFT.** Refer to paragraph 19.

(6) **INSTALL SEATS.** Refer to paragraph 67.

(7) **INSTALL TOP AND BOWS.** Refer to paragraph 66.

**b. Test.** Start engine and shift remote control shift lever into various speed positions to determine if gears in transmission are engaging properly. If gears do not engage fully, adjust remote control linkage as outlined in paragraph 13 d.

# TRANSMISSION

RA PD 66890

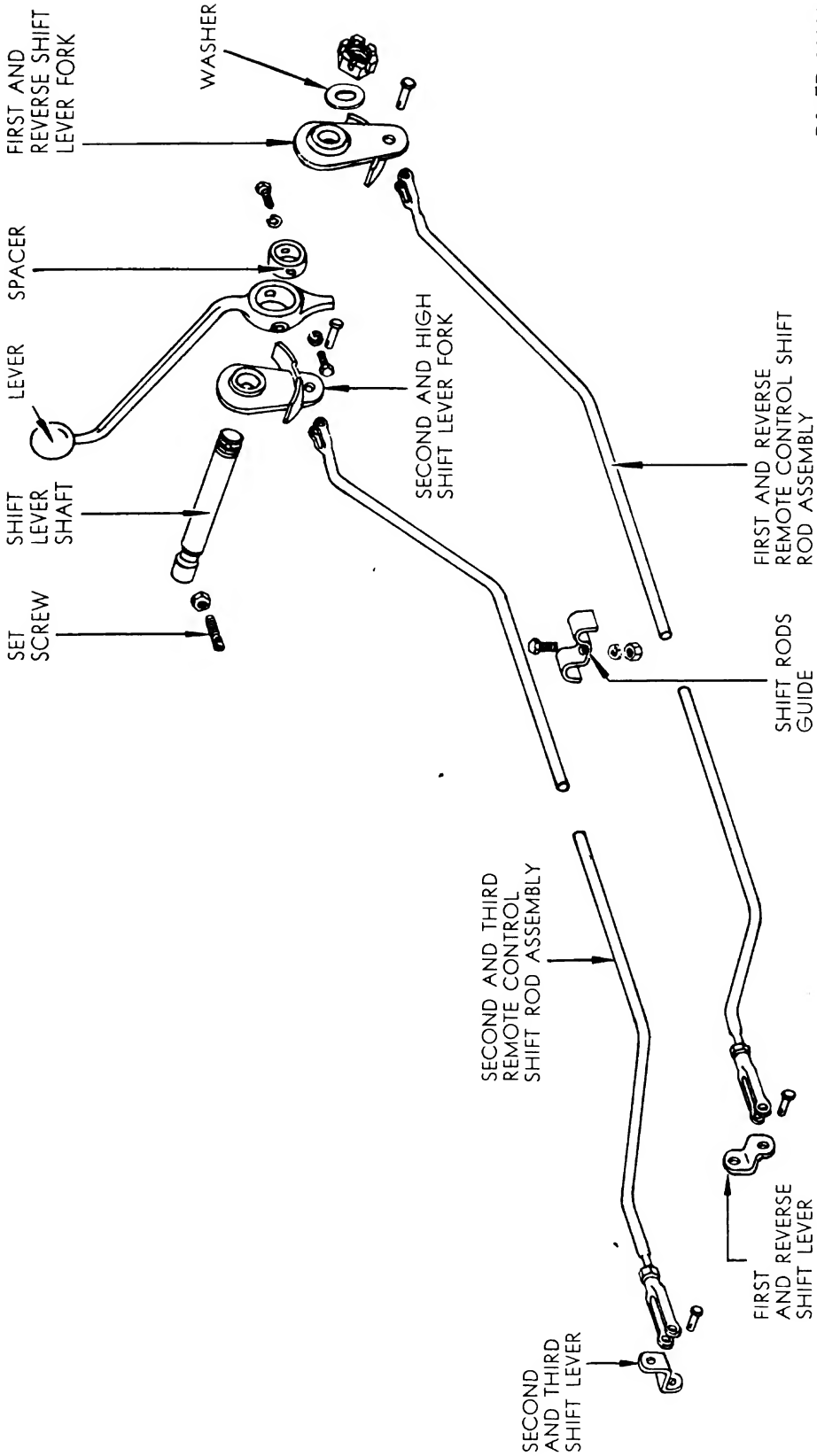


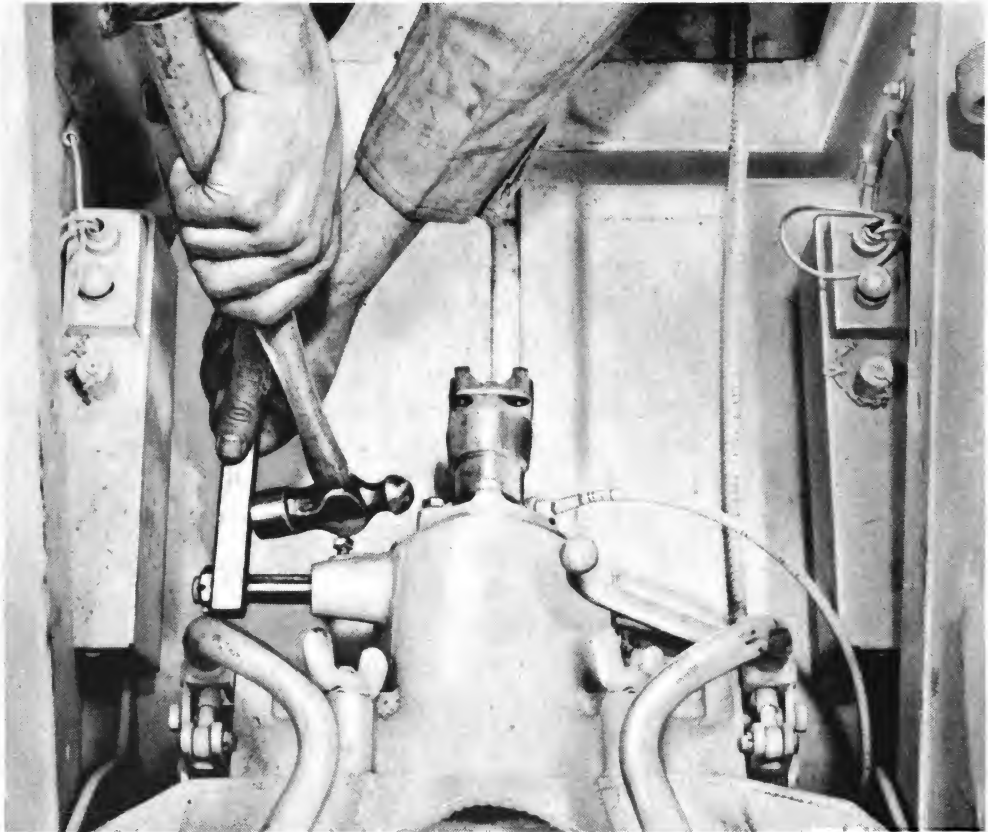
Figure 29 — Transmission Control Parts

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****13. TRANSMISSION CONTROLS AND LINKAGE.**

a. **Description.** The function of the transmission controls is to provide a means of shifting the transmission into the different gear positions. This is accomplished by a shift lever and rods running to the external levers on the transmission case (fig. 29).

b. **Removal of Controls and Linkage.**

- (1) REMOVE TOP AND BOWS. Refer to paragraph 66.
- (2) REMOVE SEATS. Refer to paragraph 67.



RA PD 49419

**Figure 30—Removing Transmission Shift Lever Shaft**

(3) REMOVE REMOTE CONTROL SHIFT RODS. Remove the four cap screws with flat washers and lock washers that retain the propeller shaft cover in position, and lift cover out of cockpit. Disconnect shift rods at both ends by removing cotter pins and clevis pins. Remove bolt and nut with lock washer holding shift rod guide in place. Move rods up and to right side of vehicle to clear propeller shaft. Lift rods from cockpit for inspection, repair, or replacement.

(4) REMOVE REMOTE CONTROL SHIFT LEVER AND RELATED PARTS. Remove the cotter pin, large castle nut, and heavy washer from remote



## TRANSMISSION

control shift lever shaft. Remove outer control lever with fork and bearing, remote control shift lever with spacer, and inner control lever with fork and bearing from shift lever shaft. If vehicle transmission remote control shift lever shaft is to be replaced, loosen lock nut on the set screw that retains shaft in a boss on right side of axle unit transmission case. Remove set screw and pull shaft out of bore in housing. If shaft cannot be pulled out easily, install the castle nut on threaded end of shaft; then place a bar of inch-square stock against inner side of castle nut, and drive shaft out of bore by striking bar with a hammer (fig. 30).

**c. Inspection and Repair.** Clean parts with dry-cleaning solvent and dry them with a clean cloth. Examine parts for cracks or damage. Inspect bearings in control lever for scores or other damage, and replace levers if necessary. If spacer in remote control shift lever is damaged, remove the two trunnion screws with lock washers that retain spacer in position, and slip it out of the lever. The shift lever spacer bore can be dressed down if it is rough, but must be replaced if broken. If shift rods have been bent from their original shape, straighten or replace.

**d. Installation of Controls and Linkage.**

(1) **INSTALL REMOTE CONTROL SHIFT LEVER SPACER.** Place spacer in elongated hole near lower end of shift lever, and install both trunnion screws with lock washers that retain spacer in position.

(2) **INSTALL REMOTE CONTROL SHIFT LEVER AND RELATED PARTS.** If vehicle transmission remote control shift lever shaft has been removed, make sure shaft bore in axle housing is free from burs. Insert shaft in bore, and tap on end of shaft, if necessary, until groove near inner end of shaft is aligned with set screw hole. Install the set screw, tighten securely, and lock with the lock nut. Apply SAE 10 engine oil to shaft and control lever bearing surfaces. Install inner control lever with fork and bearing, remote control shift lever with spacer, and outer control lever with fork and bearing in position on shift lever shaft. Place heavy washer over shaft against outer control lever hub. Install large castle nut on threaded end of shaft and tighten until end play of levers is barely perceptible. Use a new cotter pin to lock the nut in place.

(3) **INSTALL REMOTE CONTROL SHIFT RODS.** Place shift rods in position; the longer rod, operating the second and high shift fork, goes on the left. Install shift rod guide with bolt, nut, and lock washer. At the front, connect both shift rods to control levers with clevis pins and new cotter pins. With remote control shift lever and transmission in neutral, readjust both clevises at rear of rods, if necessary, so that holes in each clevis are aligned with hole in transmission external shift lever. Install clevis pins and use new cotter pins. Apply a few drops of SAE 10 engine oil to clevis pins, and on rods at the guide. Test the shifting linkage for proper operation. **NOTE:** Under certain operating conditions, if transmission remote control shift rods are not properly adjusted, it is possible to engage the transmission in two gears at the same time.

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When this occurs, it is impossible to move the vehicle. If such a condition should develop, it can be corrected by disengaging the remote control shift rods from the transmission shift levers, and moving transmission shift levers to neutral position. Adjust remote control rods to proper length by moving the adjustable clevises on transmission end of control rods backward or forward, until the proper length is obtained.

(4) **INSTALL PROPELLER SHAFT COVER.** Place propeller shaft cover in position with rectangular opening toward right side of vehicle. Install and tighten securely the four cap screws with flat washers and lock washers.

(5) **INSTALL SEATS.** Refer to paragraph 67.

(6) **INSTALL TOP AND BOWS.** Refer to paragraph 66.

## CHAPTER 2

### TRANSMISSION AND PROPELLER SHAFT WITH UNIVERSAL JOINTS (Cont'd)

#### Section II

### PROPELLER SHAFT WITH UNIVERSAL JOINTS

	Paragraph
Description and data.....	14
Trouble shooting .....	15
Removal of propeller shaft with universal joints.....	16
Cleaning, inspection, disassembly, and repair of propeller shaft and universal joints.....	17
Assembly of propeller shaft and universal joints.....	18
Installation and test of propeller shaft with universal joints....	19

#### 14. DESCRIPTION AND DATA.

##### a. Description.

(1) The steel tubular-type propeller shaft functions to transmit power from the transmission to the axle unit. Welded to each end of the shaft is a yoke which carries two opposing journals of the universal joint crosses, together with bearing assemblies. The propeller shaft is protected by a sheet steel cover secured by cap screws to brackets mounted on the floor of the hull.

(2) The propeller shaft is fitted with universal joints at each end to permit smooth flow of power to the vehicle tracks, even though the engine operates in a slightly lower plane than the axle unit. The use of a splined slip joint at rear of shaft where it joins the transmission main-shaft permits endwise movement of the engine on its cushions. Two opposed journals of each joint cross with bearings and lubricant retainers are carried in a yoke on the ends of the propeller shaft. Lock rings, fitted into recessed grooves near the outer ends of the yoke eyes, retain the bearing cups and needles in position on the cross journals. At the rear joint, the other two opposed cross journals with bearings are carried in the yoke eyes of the transmission slip joint. The free bearings and cross journals at the front joint are secured to the axle unit driving flange by two U-clips (fig. 31).

(3) A Zerk-type fitting on each universal joint cross permits lubrication of the joint bearings while fully assembled and in position on the vehicle. A small, hand-operated pressure gun is required to lubricate the bearings.

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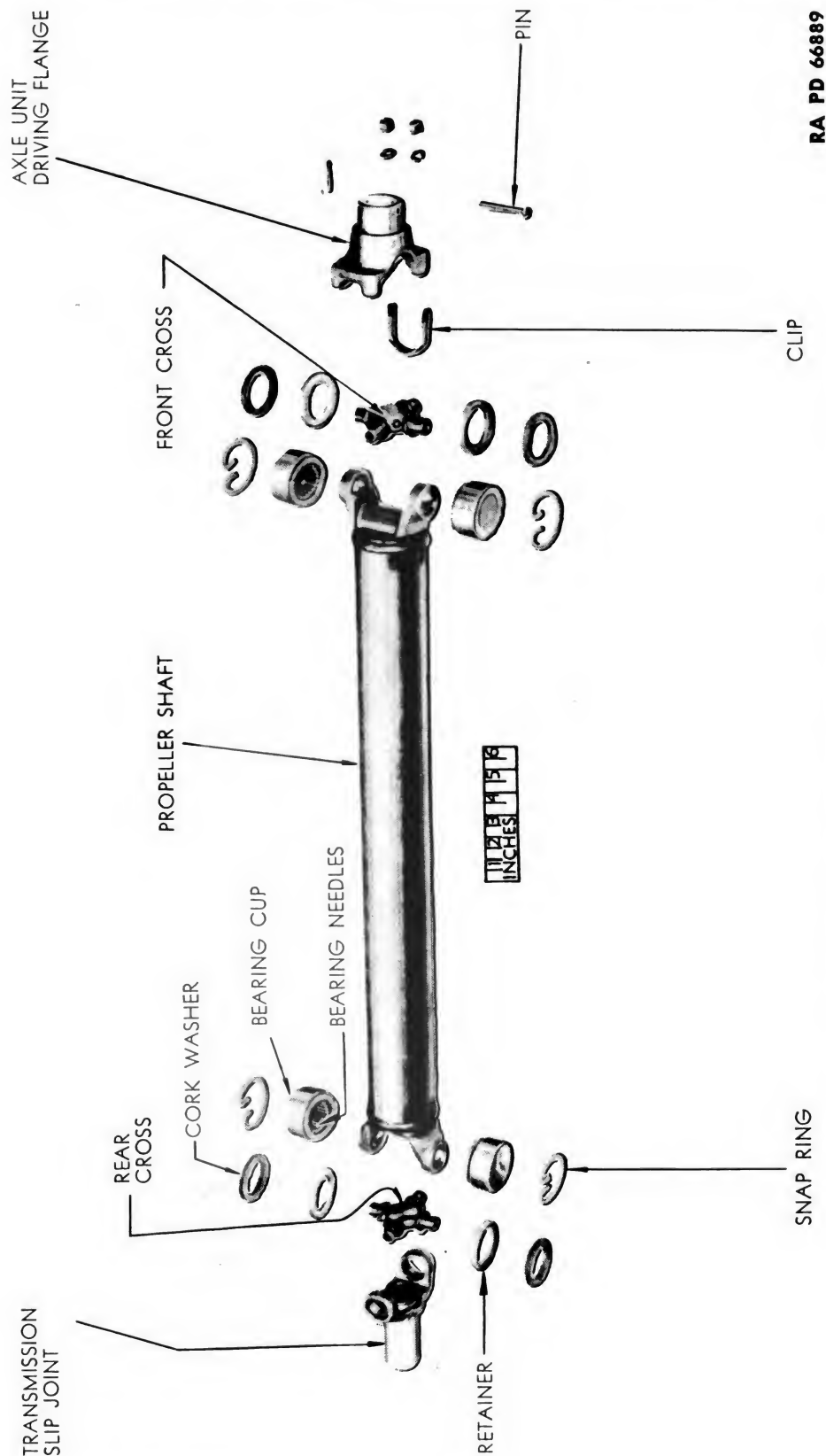


Figure 31—Propeller Shaft, Universal Joints, Transmission Slip Joint,  
and Axle Unit Driving Flange Parts

## PROPELLER SHAFT WITH UNIVERSAL JOINTS

### b. Data.

#### (1) PROPELLER SHAFT.

Make ..... Spicer  
 Manufacturer's model series ..... 1200  
 Type ..... Tubular  
 Tube diameter .....  $2\frac{3}{4}$  in.  
 Tube wall thickness ..... 0.065 in.  
 Length (center to center of crosses) ..... 29 in.

#### (2) UNIVERSAL JOINTS.

Make ..... Spicer  
 Type ..... Needle bearing  
 Number of needles per bearing ..... 23  
 Number of bearings ..... 8

## 15. TROUBLE SHOOTING.

### a. Vibration.

Possible Cause	Possible Remedy
Broken weld where yoke and propeller shaft tube join.	Replace propeller shaft and joints assembly.
Bent or sprung propeller shaft.	Replace propeller shaft and joints assembly.
Broken yoke, universal joint bearing cross, axle unit flange, or transmission slip joint.	Replace broken parts as required.
Loose or damaged universal joint bearings.	Replace cross and bearings kit.

### b. Noise.

Lubricant leakage at universal joints.	Replace cross and bearings kit.
Loose slip joint on the splined transmission mainshaft.	Replace propeller shaft and joints assembly and mainshaft, or both, as required.

**c. Diagnosis.** Unusual propeller shaft and universal joint conditions will be recognized as a definite vibration or a light, metallic, grinding noise. In cases where universal joint parts are damaged, or where the propeller shaft itself is sprung or bent, a visual inspection of the shaft and joints will not reveal the true condition present; therefore, it will be necessary to remove the propeller shaft with universal joints for a thorough examination of the parts.

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****16. REMOVAL OF PROPELLER SHAFT WITH UNIVERSAL JOINTS.**

- a. **Remove Top and Bows.** Refer to paragraph 66.
- b. **Remove Seats.** Refer to paragraph 67.
- c. **Remove Propeller Shaft Cover.** Remove the four cap screws with flat washers and lock washers and remove the propeller shaft cover (fig. 32).



RA PD 66915

**Figure 32—Removing Propeller Shaft Cover**

## PROPELLER SHAFT WITH UNIVERSAL JOINTS

d. **Remove Propeller Shaft with Universal Joints.** Remove the four nuts and lock washers holding the front joint U-clips to axle unit driving flange, and remove U-clips. Hold the two bearings released by removal of the U-clips to prevent their falling off cross, and move shaft assembly rearward to free held bearings from retaining lugs in axle unit driving flange (fig. 33). Lift front end of propeller shaft and pull forward to disengage transmission slip joint from transmission mainshaft splines. Lift propeller shaft assembly out of cockpit.

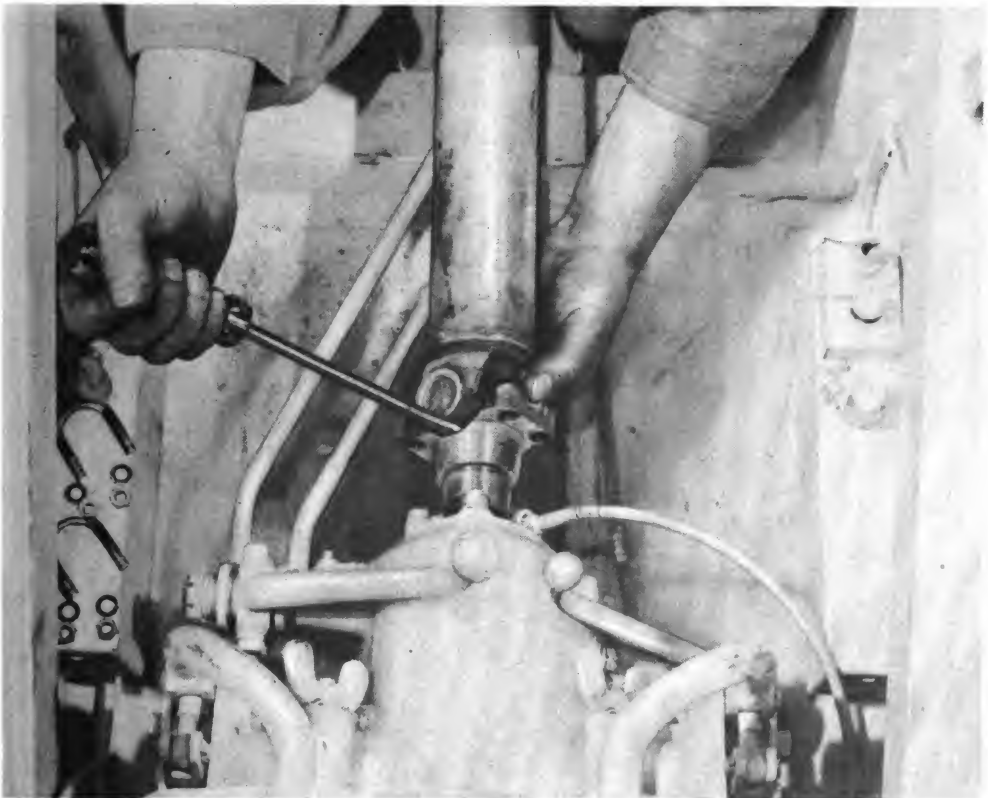
### 17. CLEANING, INSPECTION, DISASSEMBLY, AND REPAIR OF PROPELLER SHAFT AND UNIVERSAL JOINTS.

a. **Cleaning.** Apply dry-cleaning solvent with brush or cloth to remove any lubricant, dirt, or foreign matter that may have accumulated on propeller shaft and universal joints. Dry all surfaces with wiping cloths, or by using compressed air.

b. **Inspection.** Examine the assembly for cracks or external damage. Check universal joints for excessive looseness. Completely disassemble shaft and joints, and make a detailed inspection of the parts.

#### .c. Disassembly.

(1) **REMOVE FRONT UNIVERSAL JOINT CROSS FROM PROPELLER SHAFT.** With shaft and joints assembly out of vehicle, carefully remove free bearing assemblies from front joint cross. Place shaft on a bench and



RA PD 49412

**Figure 33—Disconnecting Propeller Shaft at Axle Unit Driving Flange**

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grasp loops of front joint bearing lock rings with pliers; then compress (fig. 34) and lift lock rings out of propeller shaft yoke eyes. Using a suitable clamp or an arbor press on ends of bearing cups, and tapping on clamp screw outer end after tightening it by hand, press one of the bearings inward toward center of yoke, until it has cleared the yoke eye (fig. 35). To avoid interference of the grease fitting, press the cross so that the fitting moves away from the nearest yoke eye. When the one bearing has been pressed inward, the opposite bearing will have been pressed outward and away from cross. Remove clamp and tilt cross to lift it out of yoke (fig. 36). Remove the bearing remaining on cross.

(2) **DISASSEMBLE REAR UNIVERSAL JOINT.** To disassemble the rear joint, remove the bearings that are locked in the transmission slip joint yoke eyes, and then the bearings that are locked in the shaft yoke eyes. Follow exactly the same procedure as in the removal of the front bearing assemblies and cross.

d. **Cleaning.** Clean all parts carefully in dry-cleaning solvent and blow them dry with compressed air. Permit the needle bearings to remain in the dry-cleaning solvent for some time to loosen any particles of hard grease. Then use a brush having short stiff bristles to clean the bearing parts thoroughly. Clean all grease from the passages in the crosses.



RA PD 49433

**Figure 34—Removing Universal Joint Bearing Lock Ring**



## PROPELLER SHAFT WITH UNIVERSAL JOINTS

### e. Inspection and Repair.

(1) **PROPELLER SHAFT.** A thorough inspection of the propeller shaft may reveal damaged or broken yokes, or broken welds where the yokes and propeller shaft are joined. In either case, repairs are not advisable because the balance of the propeller shaft might easily be affected, and this would result in excessive vibration and premature wear. Replace the assembly.

(2) **TRANSMISSION SLIP JOINT AND AXLE UNIT DRIVING FLANGE.** It is important for the axle unit driving flange to fit snugly on axle unit mainshaft to reduce possibility of vibration. If any excessive looseness exists at axle unit driving flange, replace flange. If the bearing retaining lugs on flange are damaged, flange must be replaced, unless it can be restored to give additional satisfactory service by dressing off any burs. The transmission slip joint is splined for endwise movement on transmission mainshaft and must slide freely. Any burs, dirt, or foreign matter affecting the free movement of slip joint on transmission mainshaft must be removed. Rough spots found on the area which contacts



RA PD 49434

**Figure 35—Removing Universal Joint Bearings**

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RA PD 49435

**Figure 36—Removing Universal Joint Cross**

the mainshaft oil seal must be removed with abrasive, aluminum oxide cloth to prevent premature damage to the seal. Replace the propeller shaft and joints assembly if any unrepairable condition is observed at the splines, sleeve portion, or yoke eyes of the slip joint.

(3) **UNIVERSAL JOINT CROSSES AND BEARINGS.** Inspect carefully for any damage to the universal joint bearing cups, bearing needles, or to the crosses. If the parts are damaged, replace them with a universal joint cross and bearings kit.

**18. ASSEMBLY OF PROPELLER SHAFT AND UNIVERSAL JOINTS.**

a. **Prepare Universal Joint Crosses and Bearings for Reassembly.** Load each bearing cup with 23 needles, using a light coating of No. 0 grease in the bearing cups to hold and locate the needles; then pack the assembly with a small amount of No. 0 grease. Pack the passages in the crosses with No. 0 grease.

b. **Assemble Rear Universal Joint Cross to Shaft.** In reassembling the component parts to the propeller shaft, place the shaft on a bench so that one yoke extends over the edge with both eyes in a vertical plane. Install a bearing lock ring in the groove in the yoke lower eye. Place a bearing cup with needle bearings on one of the cross journals, tilt the cross, and insert the opposite journal into the yoke upper eye. Straighten the cross and start the bearing assembly, which is on the lower journal,

## PROPELLER SHAFT WITH UNIVERSAL JOINTS

into the yoke lower eye. Install a bearing assembly on the upper journal (fig. 37) and apply pressure to force the bearing assemblies into the yoke eyes. After tightening the clamp by hand, tap outer end of clamp screw with a hammer. Apply pressure until lock ring groove in yoke upper eye is clear, and install a lock ring. Oscillate cross to determine if a binding condition is present at the seals. To relieve any binding, alternately tap outward against the cross inner shoulders adjacent to the bearings (fig. 38).

c. **Assemble Transmission Slip Joint to Rear Cross.** Turn propeller shaft so that free journals of cross just installed are in a vertical plane. Follow the procedure outlined previously to assemble the bearings, transmission slip joint with yoke, and lock rings on the cross free journals. It will be necessary to hold the slip joint and tilt it as required while performing the installation (fig. 39). Check for free operation of the bearings in the slip joint yoke and proceed as directed previously, if a binding condition is present at the seals.

d. **Assemble Front Universal Joint Cross to Propeller Shaft.** Assemble the remaining universal joint cross with bearings to the propeller shaft front yoke, following the procedure given in step b above.



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**Figure 37—Installing Universal Joint Cross and Bearings**

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RA PD 49438

**Figure 38—Eliminating Bind at Bearing Seals****19. INSTALLATION AND TEST OF PROPELLER SHAFT WITH  
UNIVERSAL JOINTS.**

a. **Install Propeller Shaft with Universal Joints.** Install transmission slip joint at rear end of propeller shaft on transmission main-shaft splines. Lower front end of propeller shaft with the free bearings held in place by a suitable clamp. Move the shaft forward so the front universal joint free bearings enter recesses in axle unit driving flange (fig. 40). Tighten clamp as necessary so bearings will seat properly between bearing retaining lugs in driving flange recesses. Install the U-clips and nuts with lock washers, and tighten the nuts securely. Remove the clamp.

b. **Install Propeller Shaft Cover.** Install propeller shaft cover with rectangular opening to right side of vehicle. Tighten the four cap screws which secure the cover to mounting brackets at the floor in the cockpit.

# PROPELLER SHAFT WITH UNIVERSAL JOINTS



RA PD 49436

**Figure 39—Installing Slip Joint on Cross**



RA PD 49411

**Figure 40—Installing Propeller Shaft at Axle Unit Driving Flange**

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- c. **Install Seats.** Refer to paragraph 67.
- d. **Install Top and Bows.** Refer to paragraph 66.
- e. **Test.** Shift the axle unit to its neutral position and start the engine. Test operation of propeller shaft and universal joints by engaging the various transmission gears in order to turn the propeller shaft assembly in both directions, and at different speeds. Make a final test by operating the vehicle.

## CHAPTER 2

### TRANSMISSION AND PROPELLER SHAFT WITH UNIVERSAL JOINTS (Cont'd)

#### Section III

### FITS AND TOLERANCES

	Paragraph
Transmission service data .....	20
Propeller shaft with universal joints service data .....	21

#### 20. TRANSMISSION SERVICE DATA.

##### Minimum Backlash

Pinion gear to mating gear on countershaft .....	0.004-0.008 in.
Second speed gear to mating gear on countershaft .....	0.004-0.008 in.
Synchronizer sleeve to gear .....	0.000-0.001 in.
Synchronizer gear to mainshaft .....	0.002-0.006 in.
Synchronizer sleeve to blocking rings .....	0.008-0.016 in.
Low and reverse sliding gear to mainshaft .....	0.004-0.006 in.
Pinion end play .....	Use bearing retainer and lock rings of required thicknesses to eliminate end play, but without binding bearing.
Mainshaft end play .....	Use bearing lock ring of required thickness to eliminate end play, but without binding bearing.

#### 21. PROPELLER SHAFT WITH UNIVERSAL JOINTS SERVICE DATA.

Bearing to propeller shaft joint cross clearance .....	0.020-0.015 in.
Bearing needles maximum diameter .....	0.09375 in.
Maximum permissible unbalance of propeller shaft with slip joint and driving flange assembled .....	$\frac{1}{2}$ oz-in.



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**CHAPTER 3**

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY  
WITH FINAL DRIVES**

**Section I**

**DESCRIPTION, DATA, AND TROUBLE SHOOTING**

	Paragraph
Description and operation.....	22
Data .....	23
Trouble shooting .....	24

**22. DESCRIPTION AND OPERATION.**

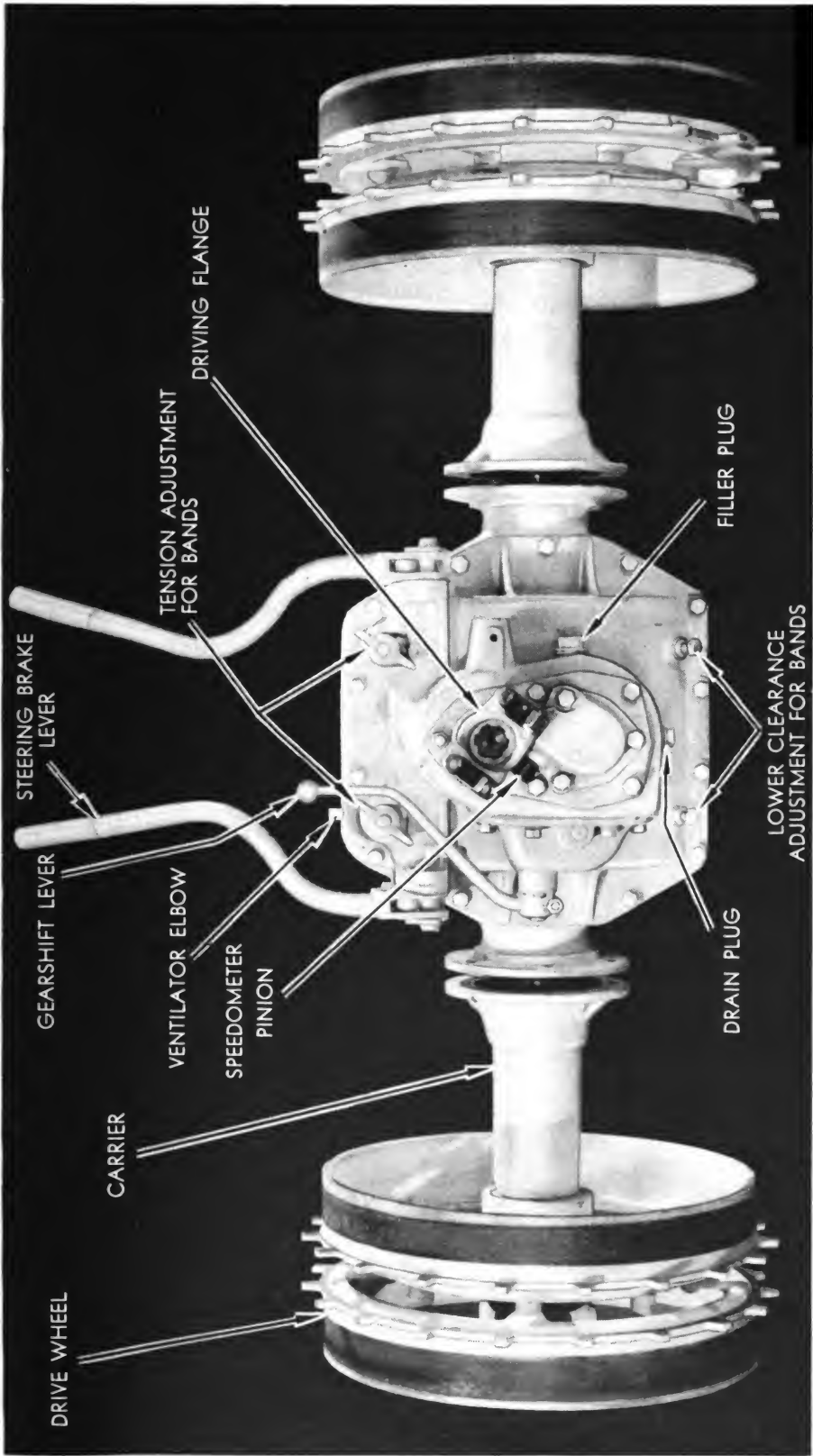
a. The axle unit and final drives are located at the front, and function to transmit engine power to the vehicle tracks. The fully encased axle unit is comprised of a two-speed transmission, an integral-controlled differential with planetary gearing, and two brake drums with hand levers for power steering, as well as for braking. The final drive consists of two wheel carrier housings, axle shafts, and track drive wheels. The housings bolt through the hull to the sides of the unit. The vehicle speedometer drive is located on the rear of the axle unit below the mainshaft driving flange. A lubricant filler plug is provided on the right side near the rear, and a drain plug is located in the bottom of the transmission case of the axle unit.

b. Engine power carried forward by the propeller shaft from the transmission is delivered at the rear end of the axle unit transmission mainshaft. Splined to the mainshaft, which is carried on opposed tapered roller bearings, are two helical-cut gears of different size; the larger one at the rear is the high speed gear, the smaller one at the front is the low speed gear. Constantly in mesh with the mainshaft gears are the axle drive pinion gears, which have internal teeth, and are carried on bearing rollers. Whenever the engine is operating, the engine transmission is in gear, and the clutch is engaged; all four of these gears (two mainshaft gears and two pinion shaft gears) turn. Between them, and splined to the pinion shaft is a sliding clutch gear used to connect the pinion shaft with the power at the will of the driver. After being turned by one of the mainshaft gears, the pinion engaged with the bevel drive (ring) gear rotates the drive wheels and vehicle tracks through a system of planetary differential gears and drive shafts.

c. At each side of the differential, the two planetary driving elements terminate within a brake drum which is connected by means of its integral hub gear to planet gears. These gears in turn are keyed to the planet pinions, which drive the axle shaft gears carried in a center



DESCRIPTION, DATA, AND TROUBLE SHOOTING



RA PD 66879

**Figure 41—Controlled Differential and Transmission Assembly with Final Drive Assemblies**

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member, to which are mounted the left housing and right housing with bevel drive gear. The axle shaft gears are splined to drive the axle shafts, which are connected by means of flanges to the track drive wheels.

**23. DATA.**

Make	Clark
Model	CE-S-125D-2
Type	Integral transmission and planetary differential.
Speeds	High and low range
High range ratio	1.152 to 1
Low range ratio	2.294 to 1
Bevel gear ratio	5.857 to 1
Steering ratio	1.61 to 1
Mainshaft bearings	2
Manufacturer's number:	
Cone	TIM-15120
Cup	TIM-15250
Drive pinion rear bearing	
Manufacturer's number:	
Cone	TIM-15100 or BOW-15100 BT
Cup	TIM-15250 or BOW-15250 BT
Drive pinion front bearing	
Manufacturer's number:	
Cone	TIM-3876
Cup	TIM-3821
Differential side bearings	2
Manufacturer's number:	
Cone	TIM-25581
Cup	TIM-25520
Drive wheel bearings (inner)	2
Manufacturer's number:	
Cone	TIM-387-A or BOW-BT-387-A
Cup	TIM-382 or BOW-BT-382
Drive wheel bearings (outer)	2
Manufacturer's number:	
Cone	TIM-359-S or BOW-BT-359-S
Cup	TIM-354-A or BOW-BT-354 A
Pinion high speed gear bearing rollers	22
Type	Needle
Diameter	$\frac{3}{16}$ in.
Length	1 in.
Pinion low speed gear bearing rollers	34
Type	Needle
Diameter	0.1873 in.
Length	1.1875 in.

Steering brake band linings .....	2
Width .....	2 in.
Length .....	29 in.
Thickness .....	$\frac{1}{4}$ in.

## 24. TROUBLE SHOOTING.

### a. Noisy in Neutral.

Possible Cause	Possible Remedy
Excessive mainshaft end play.	Add shims at rear bearing.
Mainshaft front or rear bearing dirty, rough, or damaged.	Clean or replace as required.
Teeth on mainshaft or pinion constant mesh gears scuffed, chipped, burred, or damaged.	Replace gears as required.
Bearing rollers at pinion low or high speed gears scored, rough, or damaged.	Replace bearing rollers.
Constant mesh gears not properly meshed or matched.	Replace gears.
Replacement of only one constant mesh gear, instead of both gears.	Replace both gears.
Excessive lash in constant mesh gears.	Replace defective gears.
Insufficient lubricant in axle unit.	Fill to recommended level.
Incorrect grade, or dirty lubricant in axle unit.	Drain, flush axle unit, and replace lubricant.

### b. Noisy in Gear.

Excessive axle transmission pinion end play.	Tighten pinion bearing adjusting nut.
Axle transmission pinion front or rear bearing dirty, rough, or damaged.	Clean or replace as required.
Teeth on clutch gear, or internal teeth on pinion low or high speed gears scuffed or burred.	Replace gears as required.
Excessive lash at pinion and bevel drive gear.	Remove shim at right differential side bearing and install on left side.
Pinion or bevel drive gear teeth chipped, scuffed, or burred.	Replace pinion and bevel drive gear.
Excessive clearance at either axle shaft and differential side gear splines.	Replace shaft or gear as required.
Teeth on differential side gears, planet pinions, planet gears, or steering brake drum gear chipped, scuffed, or burred.	Replace gears or drum as required.

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Possible Cause	Possible Remedy
Differential side bearings dirty, rough, or damaged.	Clean or replace as required.
Damaged bushings in differential or steering brake drums.	Replace bushings as required.
<b>c. Oil Leaks.</b>	
Lubricant level too high.	Drain to proper level.
Damaged, improperly installed, or missing gaskets.	Replace or reinstall as required.
Damaged or improperly installed mainshaft oil seal.	Replace or reinstall as required.
Axle unit drain or filler plug loose, or threads damaged.	Tighten or replace plug as necessary.
Axle unit housing, case, or cover screws loose, missing, or threads stripped.	Tighten or replace screws.
Sand hole or crack in housing, case, or covers.	Replace parts as required.
Use of lubricant which foams excessively.	Drain and refill axle unit with recommended lubricant.
Restriction in axle housing ventilator tube, causing excessive pressure in housing.	Remove tube, and either remove restriction or install new tube.
<b>d. Difficult to Shift into Gear.</b>	
Insufficient chamfer at edges of shift rod center ball notch.	Smooth edges of notches, or replace shift rod and ball as required.
Shift rod ball burred, chipped, or damaged.	Replace ball.
Pinion splines burred or damaged.	Clean, dress down, or replace pinion as required.
Clutch gear tight on pinion splines.	Clean, dress down, or replace clutch gear.
Insufficient chamfer on clutch gear teeth or internal teeth of low or high speed pinion gears.	Replace gears as required.
<b>e. Sticks in Gear.</b>	
Insufficient chamfer at edges of shift rod ball notches.	Smooth edges of notches or replace shift rod and ball.
Shift rod ball burred, chipped, or damaged.	Replace ball.
Pinion splines distorted, burred, or damaged.	Clean, dress down, or replace pinion as required.
Clutch gear tight on pinion splines.	Clean, dress down, or replace clutch gear.

## DESCRIPTION, DATA, AND TROUBLE SHOOTING

### f. Slips Out of Gear.

Possible Cause	Possible Remedy
Insufficient spring tension on shift rod ball.	Replace spring.
Excessive chamfer on edges of shift rod ball notches.	Replace shift rod.
Teeth on clutch gear, or internal teeth on low or high speed gears damaged.	Replace gears as required.

### g. Unsatisfactory Steering and Braking.

Insufficient tension on steering brake bands.	Adjust band tension.
Worn steering brake band linings.	Reline bands..
Incorrect installation of steering brake cam shafts.	Reinstall, adjust band tension, and check for proper operation.
Steering brake cam shaft splines or cam splines damaged.	Replace parts as required.
Differential side gears, planet, pinions, planet gears, or steering brake drum gears damaged.	Replace parts as required.

### h. Noisy Drive Wheels.

Excessive drive wheel end play.	Readjust at wheel bearing nut.
Wheel bearings extremely dirty or rough.	Clean or replace bearings as required.
Wheel belt bands worn away.	Replace wheel.
Wheel drive sprockets damaged or chipped away.	Replace drive wheel.

### i. Drive Wheels Will Not Rotate with Power Complete to Differential.

Drive shaft broken.	Replace drive shaft.
Drive shaft flange cap screws sheared off.	Install new drive shaft flange cap screws.
Bevel drive gear or pinion teeth stripped.	Replace bevel drive gear and pinion.

**j. Diagnosis.** With the engine operating, the engine transmission engaged, and the axle unit shift lever in its neutral (midway) position, unusual operating noises emanating from the axle unit two-speed transmission may be detected. This test should be made in an effort to locate the difficulty in the axle transmission as distinguished from the axle differential, prior to removing the axle unit from the vehicle. On the other hand, the operating check may reveal the source of the difficulty at some one of the other units in the drive line, such as the propeller shaft and joints, engine transmission or engine clutch.

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CHAPTER 3

AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY  
WITH FINAL DRIVES (Cont'd)

Section II

FINAL DRIVES

	Paragraph
Removal .....	25
Cleaning, inspection, and disassembly .....	26
Cleaning, inspection, and repair of final drive parts .....	27
Assembly, installation and test .....	28

25. REMOVAL.

- a. Remove Top and Bows. Refer to paragraph 66.
- b. Remove Front Seat. Refer to paragraph 67.
- c. Remove Tracks. Refer to paragraph 45.

d. Remove Drive Wheel and Carrier Assemblies. While an assistant holds the bolt nuts inside the cockpit, remove the bolts, copper washers, and lock washers that hold the wheel carrier flange to the axle unit housing flange. Before removing all bolts, install two guide pins, approximately 8 inches long and tapered on one end, in two of the bolt holes on each side. Install the pins directly opposite each other, to hold the spacer shims in place and preserve alinement of the axle unit in the hull. The locating pins will also facilitate assembly. Remove the last bolt and nut from each side, and pull the drive wheel and carrier assemblies outward to remove them from the axle unit. If difficulty is encountered in removing these assemblies, pressure may be applied with two small hydraulic jacks placed with bases blocked against the hull and with pads against the drive wheel. A large drift and a heavy hammer may also be used to help in the removal of the assemblies.

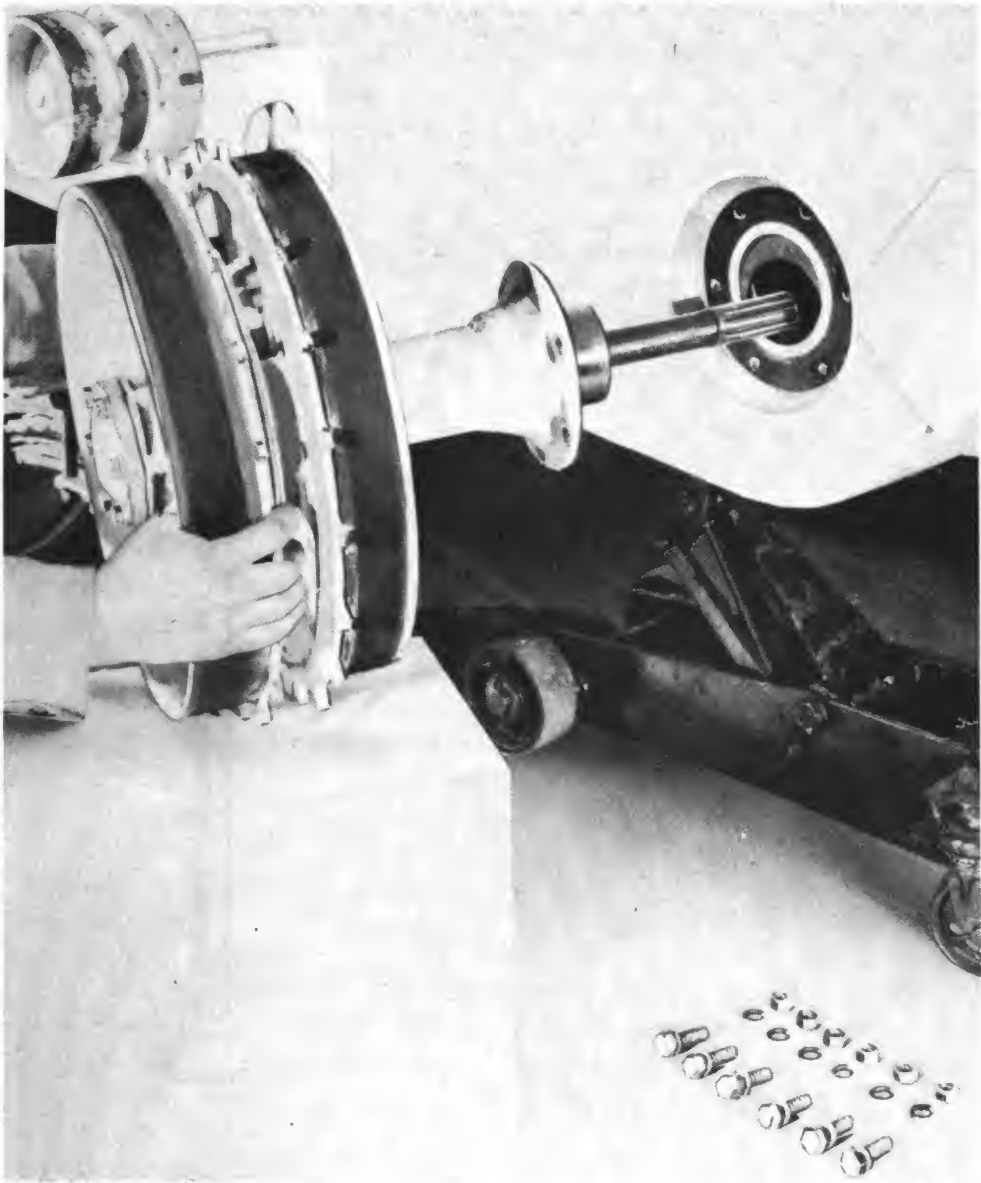
NOTE: If the axle unit is to be removed at this time it is advisable to support the weight of the axle in its position in the hull with a suitable lifting hoist before removing all of the bolts from the final drive housing flanges.

26. CLEANING, INSPECTION, AND DISASSEMBLY.

a. Cleaning. Apply dry-cleaning solvent with a brush or cloth to soak off any lubricant, dirt, or foreign matter that may have accumulated on the exterior metal surfaces of the drive wheels or carriers. If possible, do not permit any dry-cleaning solvent to collect on the wheel rubber coverings. Dry all surfaces with wiping cloths, or by using compressed air.



## FINAL DRIVES



RA PD 49406

**Figure 42—Removing Final Drive Assembly**

**b. Inspection.** Inspect the drive wheel and carrier assemblies for cracks, oil seepage, or any external damage.

**c. Disassembly.**

(1) **REMOVE DRIVE SHAFT.** Remove the drive shaft flange screws. If the drive shaft cannot be removed by hand, install two  $\frac{3}{8}$ -inch N. C. cap screws in threaded holes in drive shaft flange, and turn screws clockwise to push flange away from drive wheel hub. Pull drive shaft out of drive wheel carrier, remove the pusher screws, and scrape off the flange gasket. Repeat the procedure to remove the other drive shaft if required.

(2) **REMOVE DRIVE WHEEL AND BEARINGS FROM CARRIER.** Unlock and remove the drive wheel bearing lock nut, lock, and adjusting nut,

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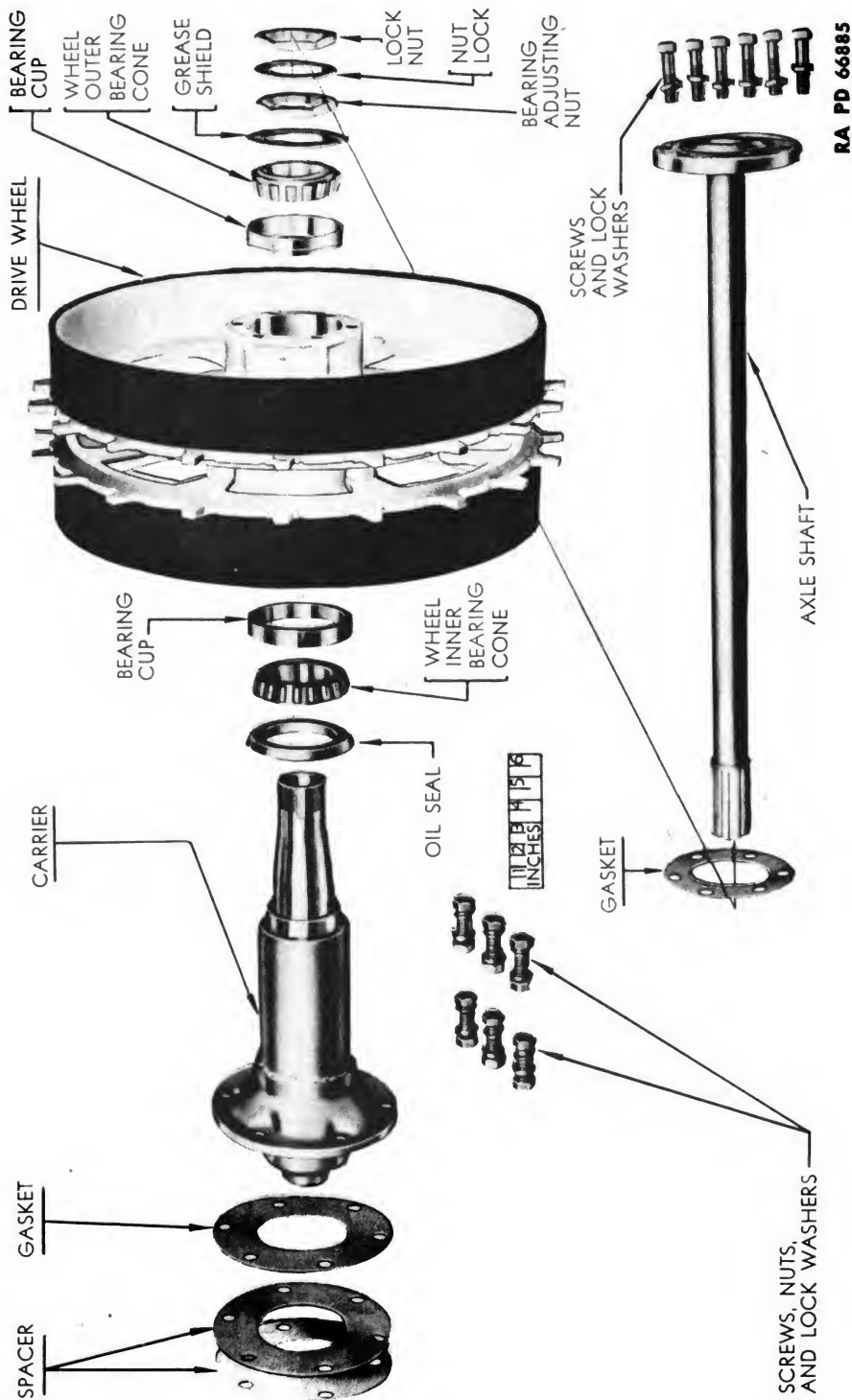


Figure 43—Parts of the Final Drive

## FINAL DRIVES

using a  $2\frac{7}{16}$ -inch single head socket wrench (41-W-2940-55). Remove the drive wheel with bearing cups. Pry the inner bearing cone and oil seal from the carrier spindle. The bearing cups may be removed for inspection or replacement with a brass drift and a hammer. Repeat the procedure outlined to remove the other drive wheel and bearings if required.

### 27. CLEANING, INSPECTION, AND REPAIR OF FINAL DRIVE PARTS.

**a. Cleaning.** Clean the shafts, wheels, and carriers carefully with dry-cleaning solvent and blow them dry with compressed air. After the bearing cones have been soaked in dry-cleaning solvent, dislodge any solid particles of lubricant that remain in the bearing cones by tapping them sharply on a wood block. Immerse the bearing cones in dry-cleaning solvent again, and agitate them to remove all traces of lubricant or dirt. Blow them dry with compressed air, being careful to direct the air at the side or face of the cone, to avoid spinning.

#### **b. Inspection and Repair.**

(1) **DRIVE SHAFT.** Inspect the shafts thoroughly for evidence of fracture, twisted splines, or burs, on machined surface of flanges. Remove any burs on the flange surface that contact the gasket, by machining or filing. If there is any evidence of fracture or twisted splines, replace the shaft.

(2) **DRIVE WHEELS.** Inspect the drive wheels for cracks, distortion, or damage. Weld any cracks found in the drive wheels, if they can be repaired to give satisfactory service. If the drive wheels are distorted or damaged, replace them.

(3) **CARRIER.** Inspect the carriers for burs, cracks, or damage, and make sure that the baffle oil drain hole inside inner end of carrier is not obstructed. Remove any burs, by machining or filing. If carriers are cracked or damaged, and cannot be satisfactorily repaired by welding, replace them.

(4) **BEARINGS.** Inspect the bearing cones and cups and if scored, damaged, or if the roller retainers are loose, replace them.

### 28. ASSEMBLY, INSTALLATION, AND TEST.

#### **a. Assembly.**

(1) **INSTALL DRIVE WHEELS AND BEARINGS ON CARRIERS.** Place a new drive wheel oil seal over the carrier spindle and drive it into position (fig. 44). Carefully install bearing cups by driving them into position in drive wheel hub with drive wheel bearing cup replacer (41-R-2394-255). Pack inside of drive wheel hub with No. 0 grease, until level with inside diameter of bearing cups. Pack the inner and outer bearing cones with No. 0 grease, and slide the inner bearing cone into place on the carrier spindle. Install the drive wheel, outer bearing cone, grease shield, and bearing adjusting nut on the carrier spindle. Adjust the drive wheel bearings until they are seated firmly and the wheel turns with difficulty, then back off the adjusting nut one-sixth turn. Install a new

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RA PD 67140

**Figure 44—Installing Drive Wheel Carrier Oil Seal**



## FINAL DRIVES

nut lock and lock nut, and lock both nuts in place by bending a portion of the lock over a flat on each of the nuts.

(2) **INSTALL DRIVE SHAFTS.** Place a new gasket on the drive wheel hub, using joint and thread compound. Carefully install drive shaft and tighten flange screws securely.



RA PD 67189

**Figure 45—Installing Drive Wheel Carrier**

### b. Installation and Test.

(1) **INSTALL DRIVE WHEEL AND CARRIER ASSEMBLIES.** Install a new gasket in place around the hull opening with joint and thread compound. Lift one of the drive wheel and carrier assemblies (make sure that the wheel carrier inner oil drain hole points downward), and enter splined end of axle shaft through opening in hull and into axle unit housing. Move carrier flange toward hull until locating pins enter bolt holes in flange (fig. 45). When splined end of axle shaft is against differential axle shaft gear, turn drive wheel until splines mesh, and push the assembly in until flange on wheel carrier is against gasket on outside of hull. Insert bolts with new copper washers through holes from the outside, while an assistant installs the lock washers and nuts inside the cockpit. Repeat the procedure to install the other drive wheel and carrier assembly. Tighten the attaching bolts and nuts securely, and fill axle unit to proper level with SAE 10 engine oil.

(2) **INSTALL TRACKS.** Refer to paragraph 47.

(3) **INSTALL FRONT SEAT.** Refer to paragraph 67.

(4) **INSTALL TOP AND BOWS.** Refer to paragraph 66.

(5) **TEST.** Start the engine and test operation of final drives by running the vehicle.

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CHAPTER 3

AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY  
WITH FINAL DRIVES (Cont'd)

Section III

AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

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Removal .....	29
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Assembly .....	36
Test of assembly .....	37
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Fits and tolerances .....	40

29. REMOVAL.

- a. Remove Top and Bows. Refer to paragraph 66.
- b. Remove Seats. Refer to paragraph 67.
- c. Remove Propeller Shaft. Refer to paragraph 16.
- d. Remove Tracks. Refer to paragraph 45.
- e. Disconnect Axle Unit for Removal. Remove the protection pad from top of axle unit housing. Disconnect axle unit ventilator pipe and carefully bend pipe forward out of the way. Free both front bomb wiring tubes by removing the machine screw, lock washer, and nut from clips, and bend the tubes up to provide clearance. Disconnect transmission remote control shift rods by removing the cotter pins and clevis pins. Remove the shift rod guide and shift rods. Loosen speedometer cable nut from sleeve, and move cable end away from axle unit.
- f. Remove Final Drives. Refer to paragraph 25.
- g. Remove Axle Unit from Cockpit. With a suitable hoist and a lift chain, raise the axle unit carefully while guiding it with the steering levers and remove axle unit from vehicle (fig. 46). Tag the hull spacer shims for proper location on reassembly. Remove drain plug from bottom of case, and drain the lubricant. Place the axle unit on a suitable bench and remove the lift chain.

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

RA PD 49398

**Figure 46—Removing Controlled Differential Unit**

**30. DISASSEMBLY.**

**a. Remove Axle Housing.** Take out the cap screws and lock washers and remove housing with gasket by striking sharply with a lead or copper hammer to loosen it from the case assembly.

**b. Remove Steering Lever and Linkage.** Remove the cotter pin and clevis pin at the adjusting clevis on one of the steering brake levers. Loosen the link cap screw and remove the screw, lock washer, link, spacer, and tension spring (fig. 48). Lift steering lever off lever pin. Repeat the procedure to remove the other lever.

**c. Remove Differential Assembly.** Remove the brake band tension adjusting wing nut and adjusting lock plate from one of the brake band studs. Remove the steering brake camshaft and cork seal (fig. 49). Repeat the steps at the other brake band. Loosen the four differential side bearing retainer plate screws, and remove the screws with toothed lock washers, plate, and shims. Tag the shims and plate so that they will be installed in the proper location on reassembly. Mark the cap for reassembly identification. Remove the two cap screws and toothed lock washers that hold the differential side bearing cap in place, and remove the cap (fig. 50). Repeat the steps to remove the other differential side bearing cap. Pull the differential assembly with brake bands out of case (fig. 51) and remove brake bands from drums.



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RA PD 66880

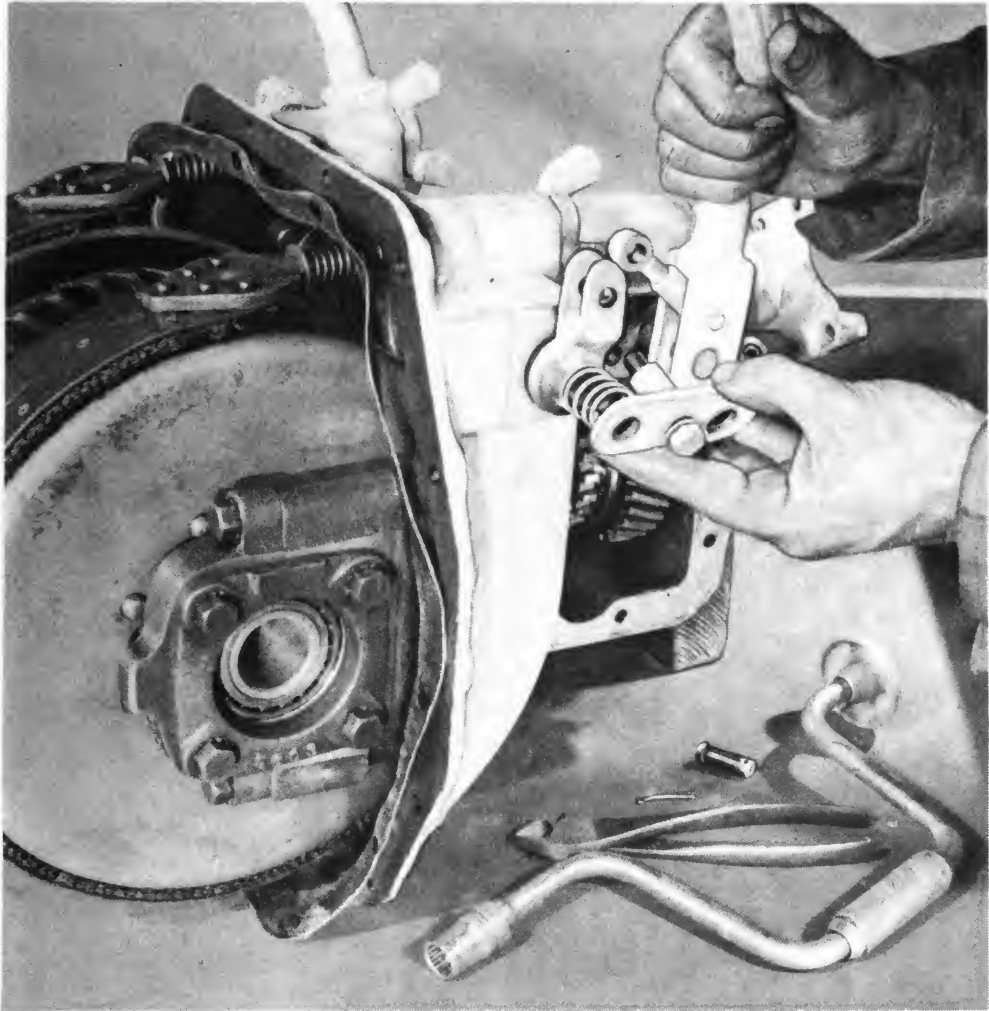
**Figure 47—Removing Axle Unit Controlled Differential Housing**

d. **Remove Axle Unit Driving Flange.** Remove the cotter pin, drive out the lock pin, and remove driving flange from splines on mainshaft.

e. **Remove Axle Transmission Shift Cover Assembly.** Take out the six cap screws with lock washers, and remove the shift cover assembly with gasket (fig. 52).

f. **Remove Axle Transmission Pinion Rear Bearing Cap Assembly.** Loosen the speedometer pinion sleeve in the bearing cap. Remove the three cap screws with lock washers, and lift off the cap assembly and gasket.

g. **Remove Axle Transmission Pinion, Bearings, and Gears.** Remove speedometer drive gear snap ring, and lift gear (number side out) off end of pinion. Remove Woodruff key from keyway. Unstake and remove the pinion rear bearing adjusting nut (fig. 53). Move the sliding gear into engagement with high-speed gear for access to low-speed gear bearing snap ring. To remove the snap ring, use a narrow-blade cold chisel, placing chisel against ring opposite the gap, and cut the ring to broken and spread it (fig. 54). Pry ring out of groove, and move it

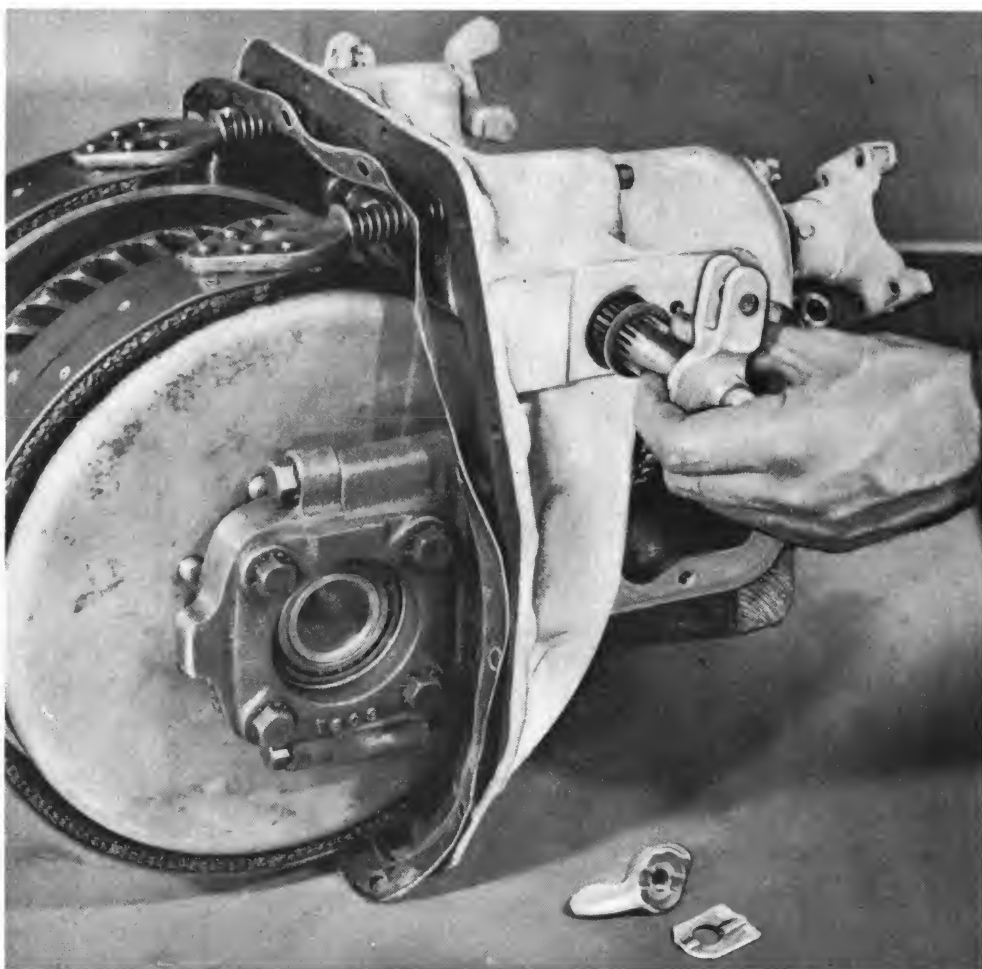
**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

RA PD 49469

**Figure 48—Removing Axle Unit Steering Lever and Linkage**

toward sliding gear. Remove axle transmission rear cover plate by first removing the four cap screws with lock washers, and one nut with lock washer; then use mainshaft rear bearing puller (41-P-2900-20) to remove the cover plate and pinion rear bearing (fig. 55). Remove cover plate gasket and shims from mainshaft rear bearing. Pull pinion carefully out of case to avoid losing any bearing rollers. Lift the sliding gear, spring washer, thrust washer, and high speed gear with locating washer from the case. Tilt low speed gear as required in order to work it out of case opening. From inside case, remove the 34 long rollers used in the low-speed gear and the 22 short rollers used in the high-speed gear.

**h. Remove Axle Transmission Mainshaft, Bearings, and Gears.** Drive mainshaft and rear bearing out rear of case with a brass drift and hammer (fig. 56). Lift the mainshaft high-speed gear, spacer, low-speed gear, and front bearing cone out of the case.

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RA PD 49470

**Figure 49—Removing Steering Brake Camshaft****31. CLEANING.**

a. Clean all parts and subassemblies with dry-cleaning solvent and dry with wiping cloths or compressed air. Permit the bearing cones to remain in dry-cleaning solvent to soak thoroughly. Strike the bearing cones sharply on a wood block to dislodge any particles. Immerse the cones again, and agitate them to remove all lubricant and dirt. Blow the cones dry with compressed air, being careful to direct the air against the side or face of the cone, to avoid spinning.

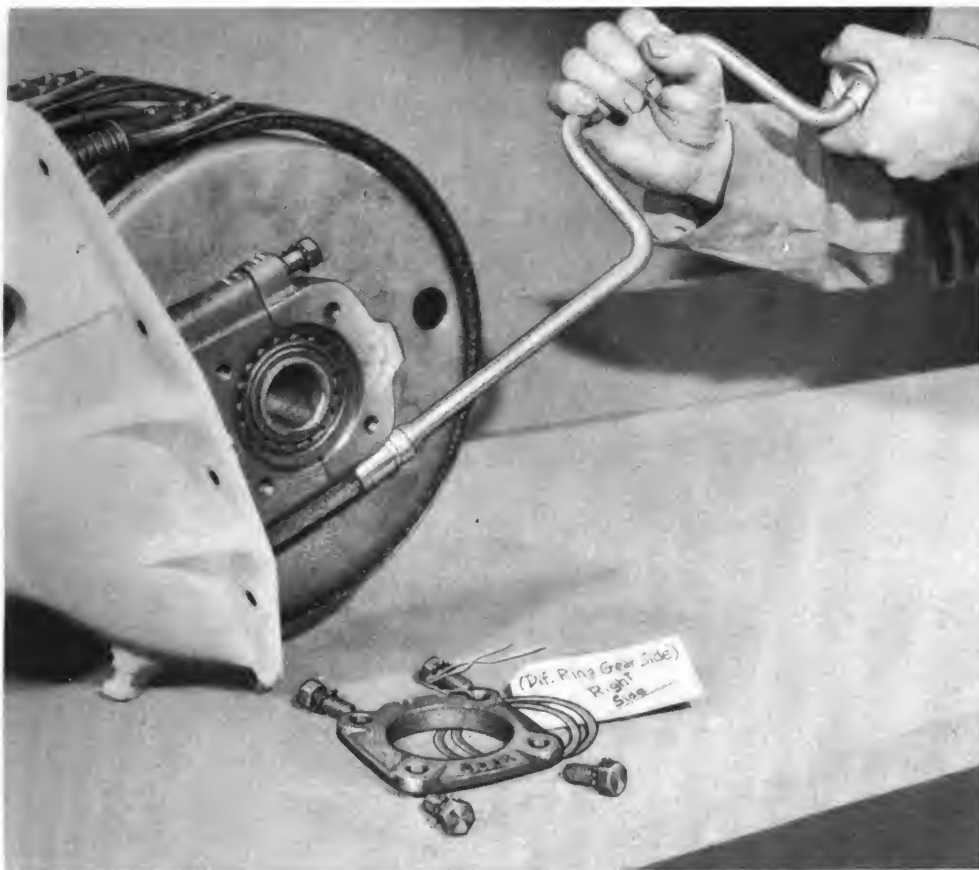
**32. DISASSEMBLY OF AXLE DIFFERENTIAL.**

a. **Remove Steering Brake Drums.** Remove the differential side bearing cones (fig. 57). Remove the differential side bearing snap ring spacer with snap ring pliers, and lift the steering brake drum with gear off the differential right housing hub (fig. 58). Repeat the pro-

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

cedure to remove the snap ring spacer and drum with gear from the differential left housing hub.

b. **Remove Right Differential Housing with Bevel Drive Gear, Planet Gears and Pinions from Center Member.** Remove lock wires from the six cap screws that secure right differential housing to center member. Remove three of the six cap screws that hold right housing to



RA PD 49475

**Figure 50—Removing Differential Side Bearing Cap**

center member. Loosen the remaining three cap screws about one-fourth inch at a time, and after blocking under bevel drive gear, drive downward on the screw heads, using a brass drift and hammer, to separate right housing from center member (fig. 59). Remove the three cap screws and lift right housing assembly off center member. Lift differential right axle shaft gear out of center member.

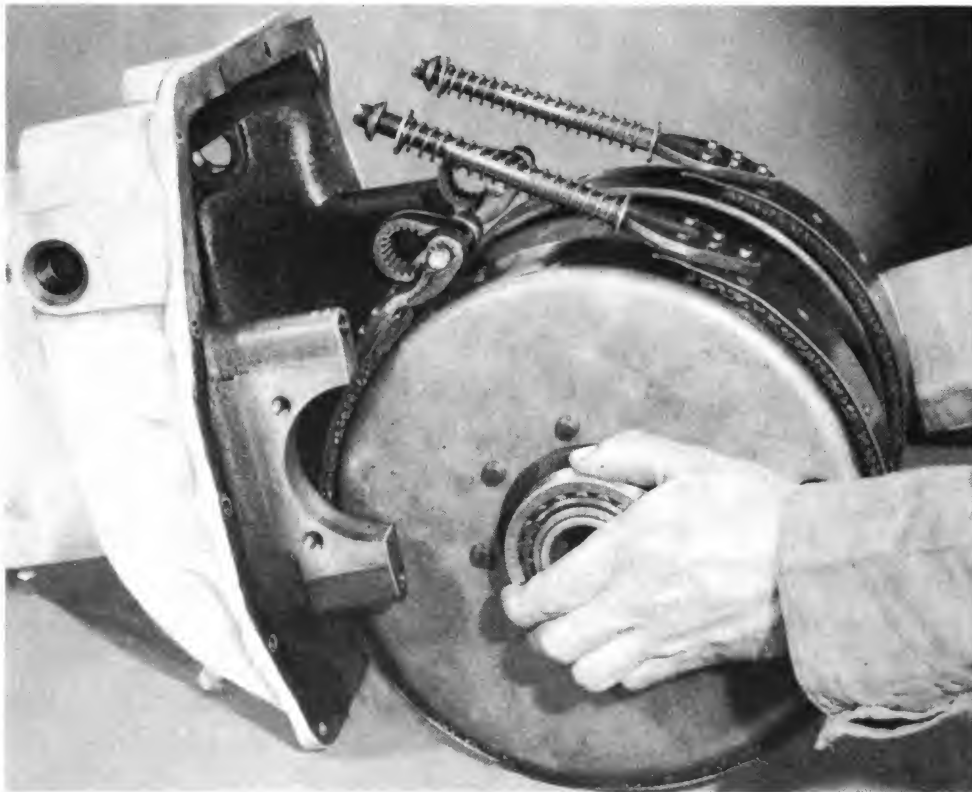
c. **Remove Left Differential Housing with Planet Gears and Pinions from Center Member.** Remove lock wires from the six cap screws that hold left differential housing to center member. Block under housing flange, and loosen the six cap screws about one-fourth inch at a time. Drive downward on the screw heads, using a brass drift and ham-

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mer, to separate left housing from center member (fig. 60). Remove the three cap screws that are free, and lift left housing off center member. Lift differential left axle shaft gear out of center member.

**33. DISASSEMBLY, INSPECTION, REPAIR, AND ASSEMBLY OF AXLE DIFFERENTIAL COMPONENTS.**

a. **General.** The disassembly, cleaning, inspection, repair, and re-assembly of the various subassemblies must be performed with care



RA PD 49471

**Figure 51—Removing Differential Assembly with Brake Bands from Case**

and cleanliness. To avoid confusion or error treat each subassembly as a unit. Mark certain related parts before they are disassembled, to aid in subsequent assembly operations. Carefully clean each component after disassembly. Inspect the various parts carefully and thoroughly to determine their fitness for further service.

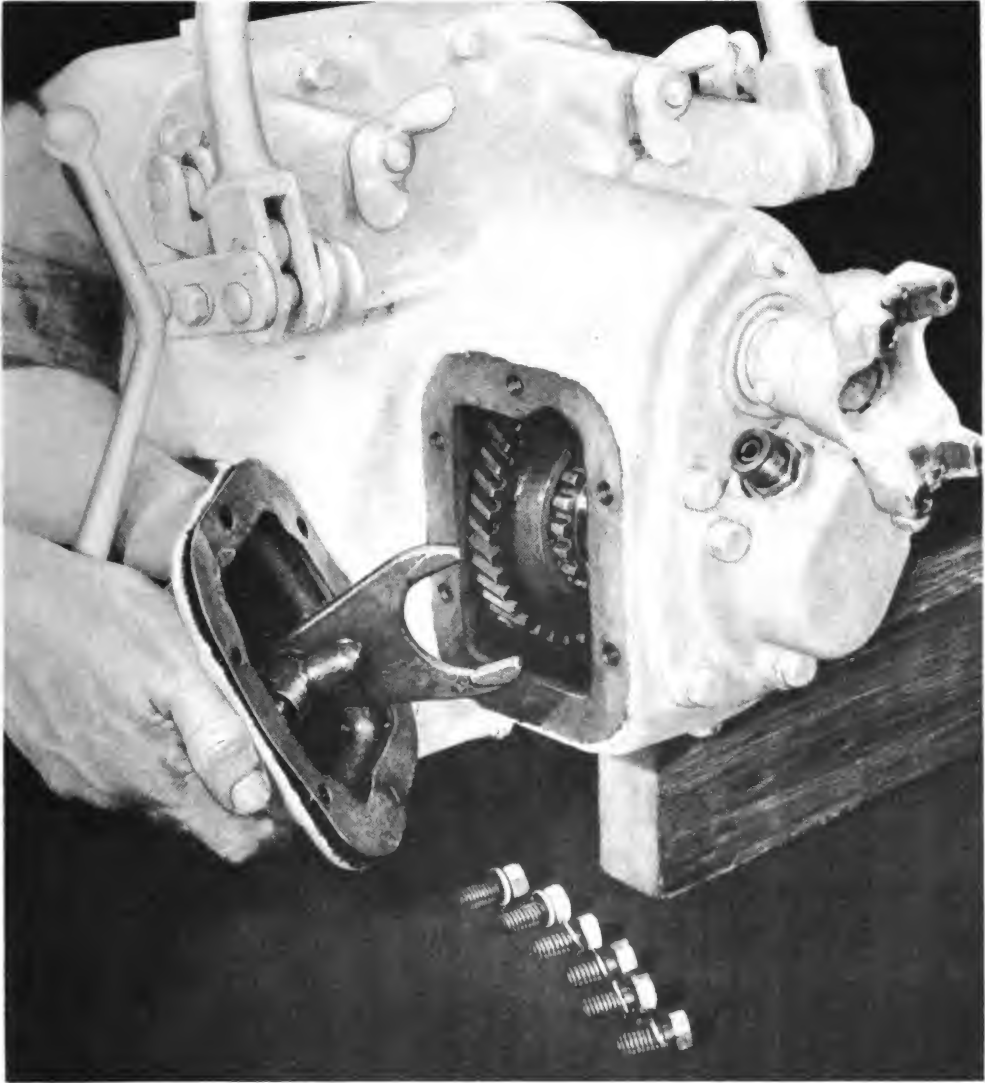
**b. Steering Brake Bands.**

(1) **DISASSEMBLE.** Lift the cork oil seals, flat washers, coil springs, and flat washers off the band adjusting studs that are riveted to the bands. Remove the cam lock pin, cotter pins and lock pins so that cams are free from cam yokes riveted to the bands (fig. 61).



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

(2) **INSPECTION.** Clean all metal parts in dry-cleaning solvent. Examine coil springs for breakage. Inspect cams and cam lever shafts for burred or chipped splines, or other damage. Examine bands, yokes, and studs for breakage or other damage. Examine band linings for wear or damage. Notice whether or not the heads of rivets securing linings to bands are flush, or nearly flush, with drum contacting surface



RA PD 66881

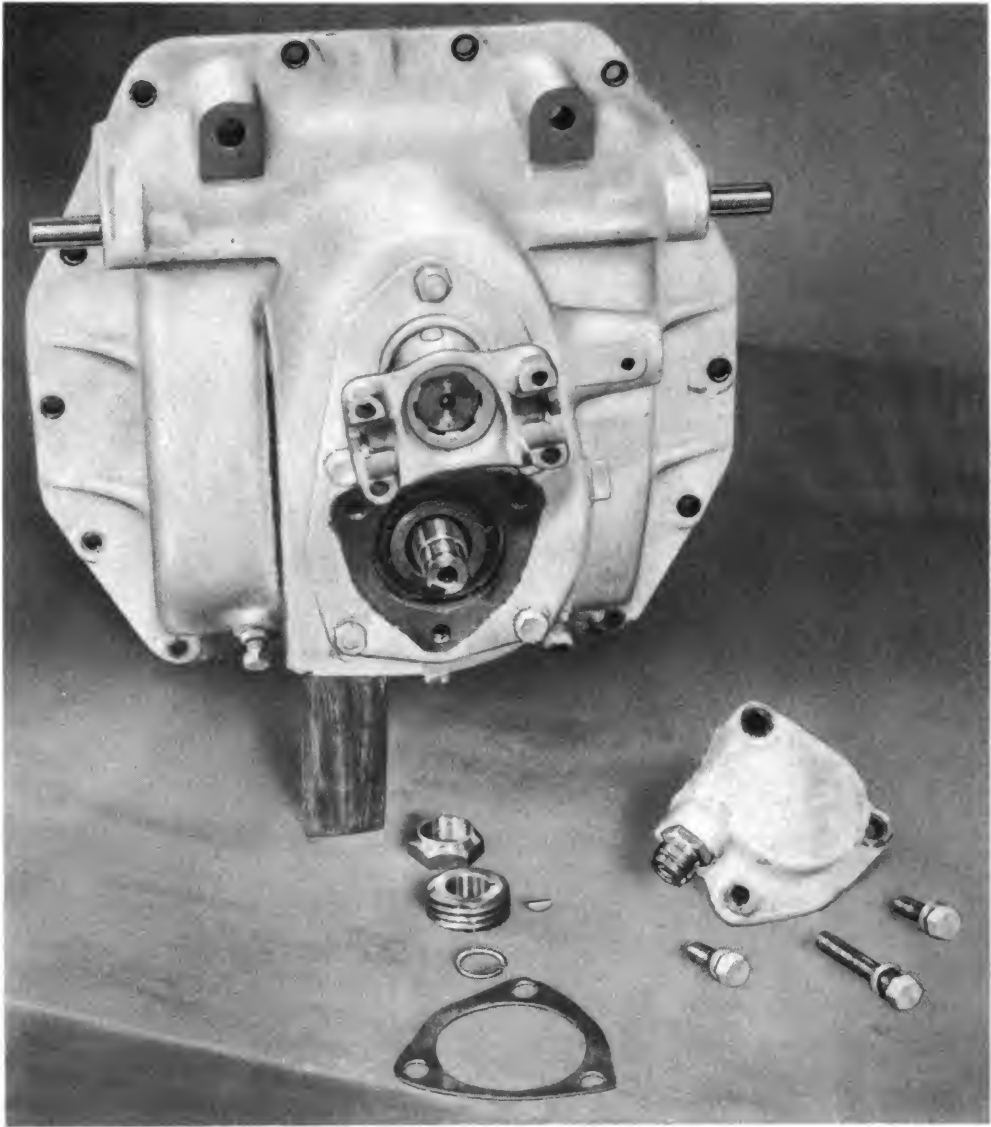
**Figure 52—Removing Shift Cover Assembly**

of linings. Inspect steering brake levers for breakage, and adjustable linkage for stripped threads.

(3) **REPAIR.** If coil springs are broken, install new springs during reassembly. Install new cams and lever shafts if damaged splines are found. Install new cork seals on band studs and cam lever shafts during

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reassembly. If the bands with riveted studs and yokes are in any way damaged beyond repair by reriveting, or chasing the stud threads, replace the bands. If band linings are worn flush or nearly flush with the rivet heads that secure linings to bands, install new linings. To do this, remove rivets by driving them out of bands, working toward ends of



RA PD 49459

**Figure 53—Pinion Rear Bearing Cap, Speedometer Drive Gear, and Bearing Adjusting Nut Removed**

linings. Replace steering brake levers if broken, and adjustable linkage if threads are stripped.

(4) **ASSEMBLE.** Install the steering brake cams, lock pins, and new cotter pins. On each band stud, install a flat washer, a coil spring, a flat washer, and a new cork seal.



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**



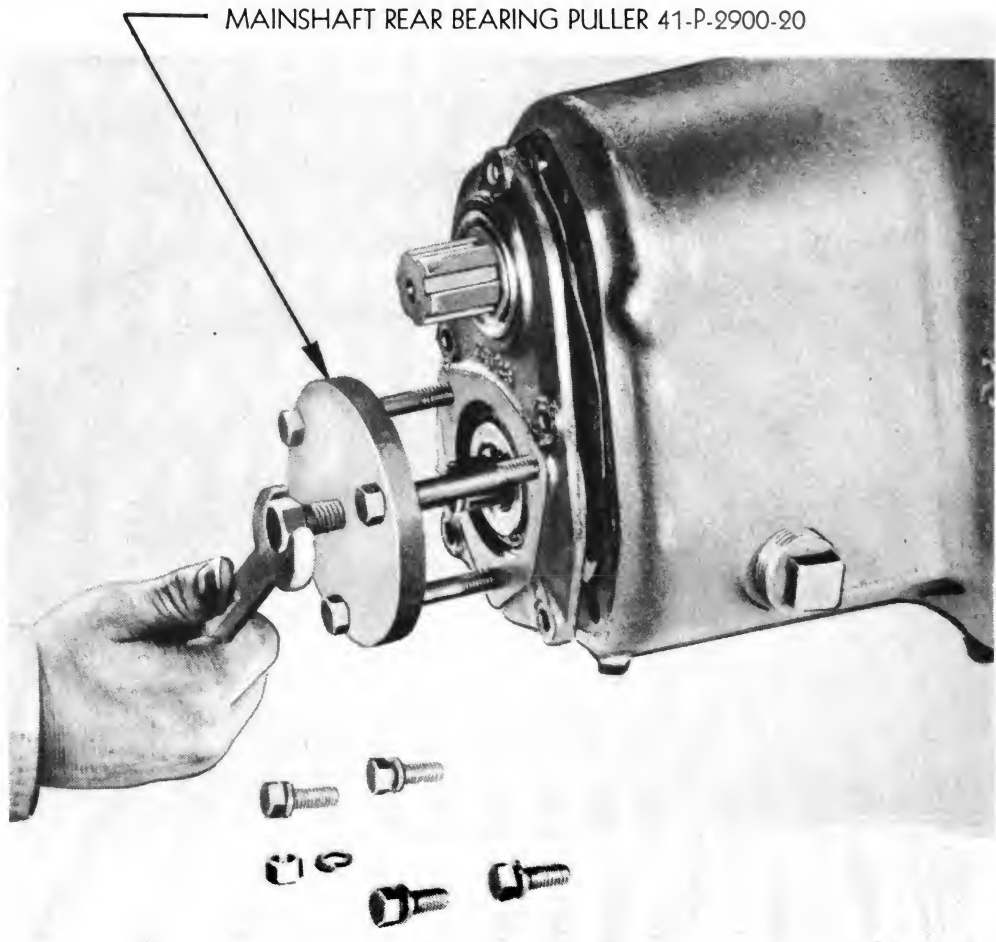
RA PD 49458

**Figure 54—Cutting Pinion Low Speed Gear Snap Ring for Removal**

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****c. Steering Brake Drums.**

(1) **DISASSEMBLE.** Disassembly of the steering brake drum is not advisable.

(2) **INSPECTION.** Clean the drum assemblies in dry-cleaning solvent. Inspect the lining contact surface of drums for grooves, roughness, and



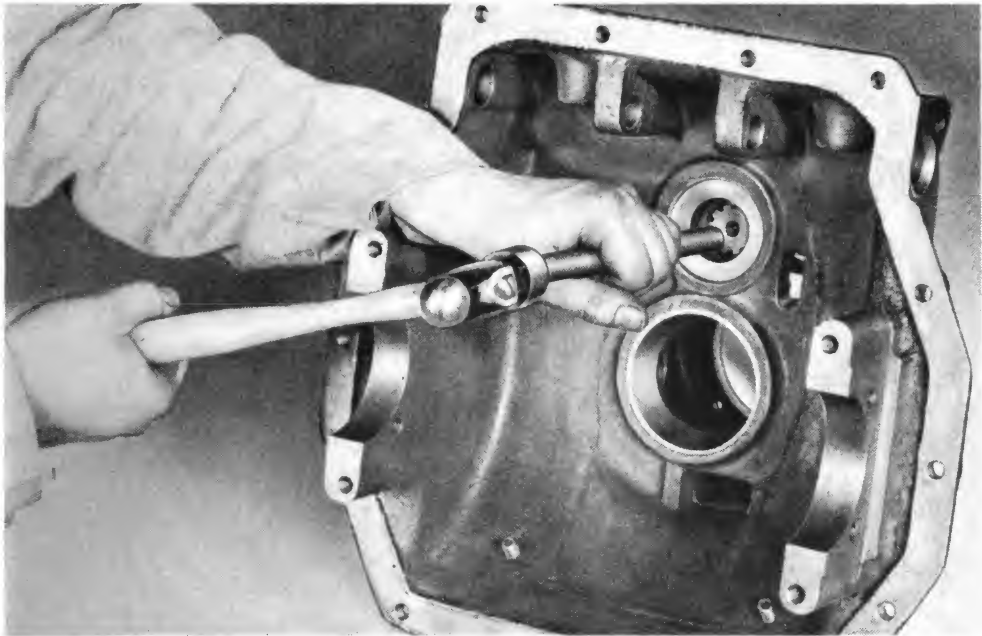
RA PD 67270

**Figure 55—Removing Axle Transmission Rear Cover Plate and Pinion Rear Bearing**

distortion. Examine gear and bushing in each drum for looseness or damage.

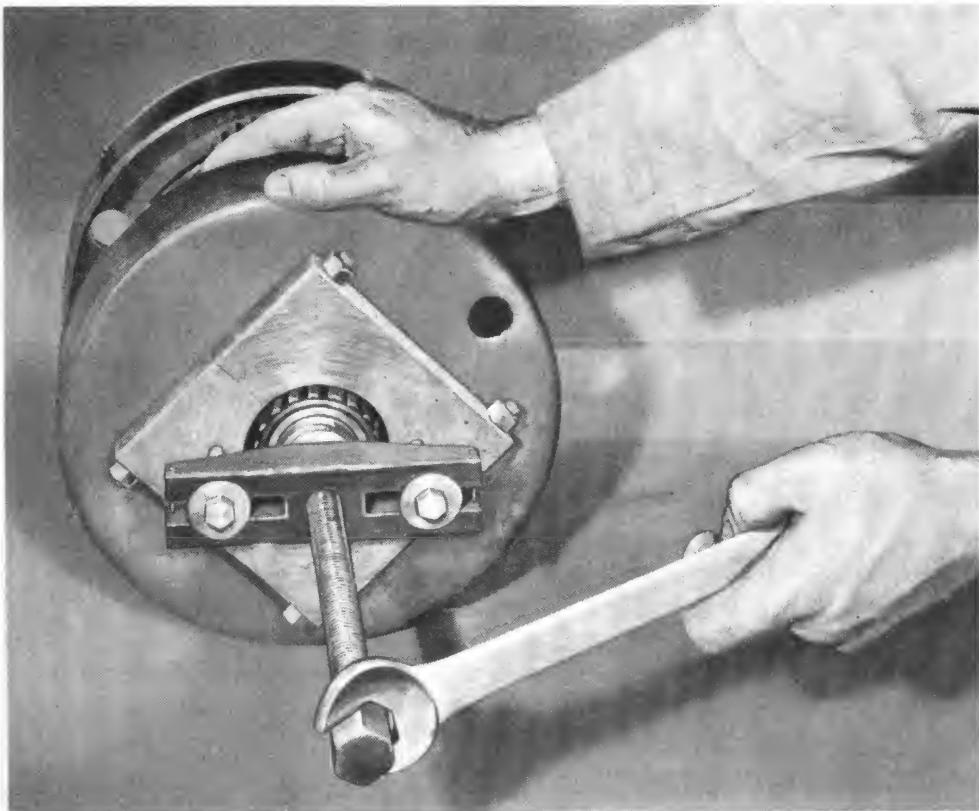
(3) **REPAIR.** If drums are distorted or the lining contacting surfaces are badly grooved, replace drums. If the lining contacting surfaces are only rough, they can be made serviceable by polishing with aluminum oxide abrasive cloth. If gear teeth are broken, or gear flanges loose, replace drum assemblies. If bushings are loose or damaged, replace drum assemblies.

## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY



RA PD 67164

**Figure 56—Removing Axle Transmission Mainshaft**

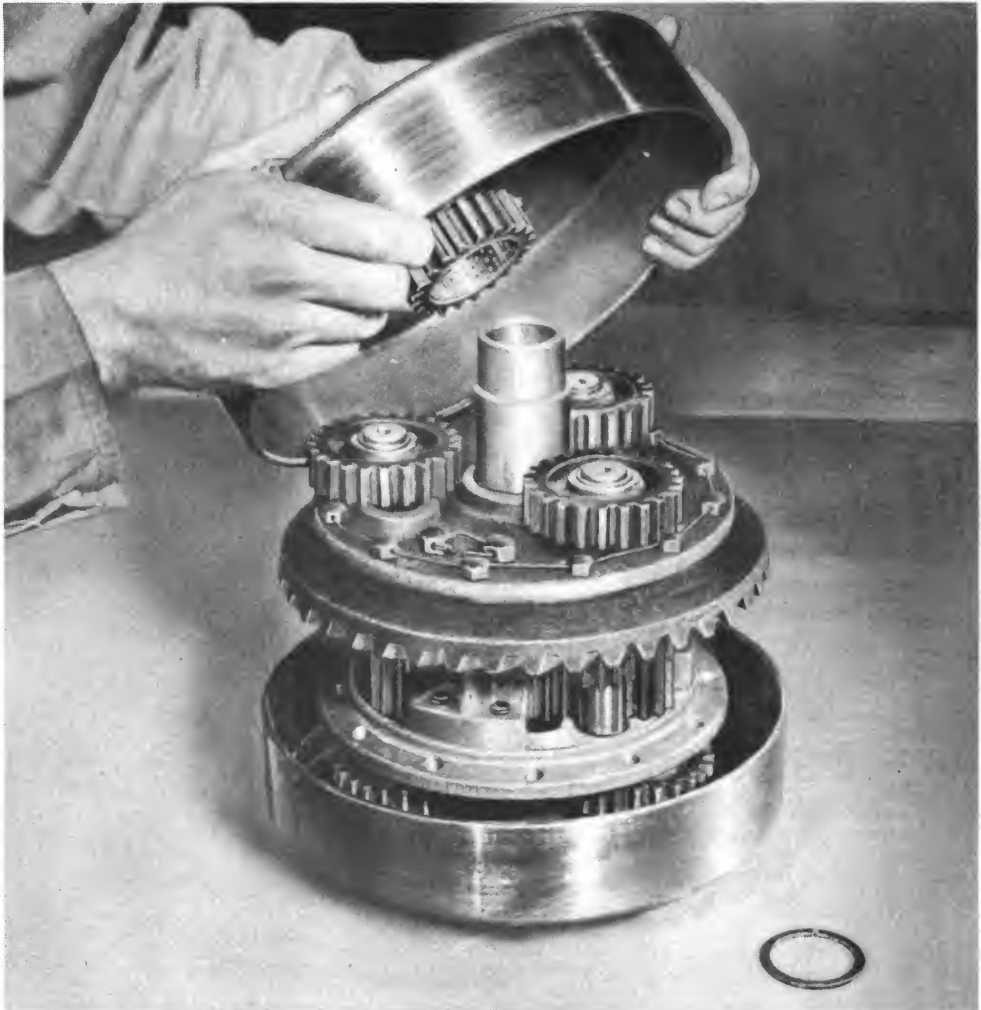


RA PD 49476

**Figure 57—Removing Differential Side Bearing Cone**

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****d. Left Differential Housing, Planet Gears and Pinions, and Bushings.**

(1) **DISASSEMBLE.** Remove planet gear snap rings from outer ends of planet pinions with snap ring pliers and screwdriver. Pull each planet gear from its planet pinion (fig. 62). Remove Woodruff keys from keyways, and slide pinions out of housing, after marking housing to indicate from which bore each pinion was removed.



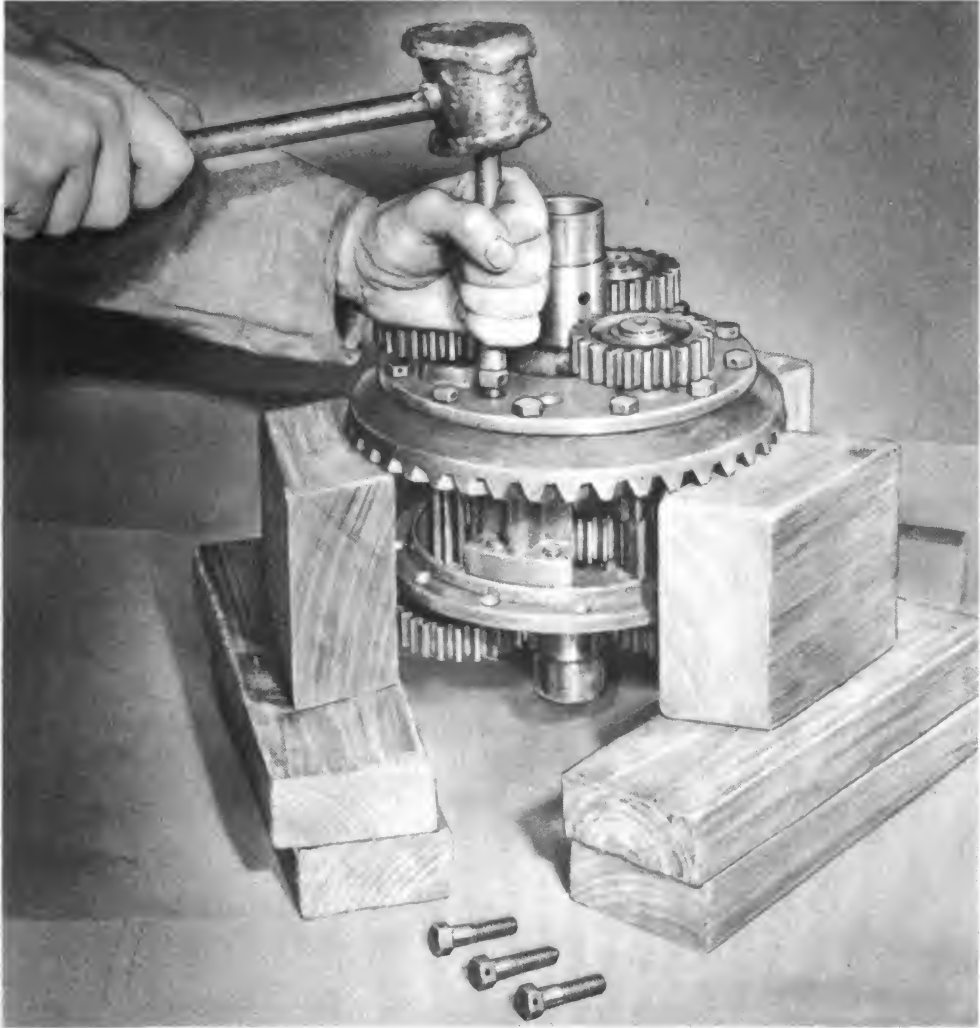
RA PD 49477

**Figure 58—Removing Steering Brake Drum and Gear Assembly**

(2) **INSPECTION.** Clean all parts in dry-cleaning solvent. Examine housing for cracks, scores, or other damage. Inspect planet gears and pinions for nicked or broken teeth, or other damage. Inspect the six planet pinion bushings and the differential axle shaft gear bushing for looseness or damage.

### AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

(3) **REPAIR.** If the housing or hub is damaged or broken, replace it. Replace any planet gears having damaged teeth. If the bushing contacting surfaces on planet pinions are damaged and cannot be restored by smoothing with aluminum oxide abrasive cloth, or if pinion teeth are broken, replace pinions. Replace damaged Woodruff keys on reassembly, and install new planet gear snap rings. Replace any planet pinion bush-



RA PD 66873

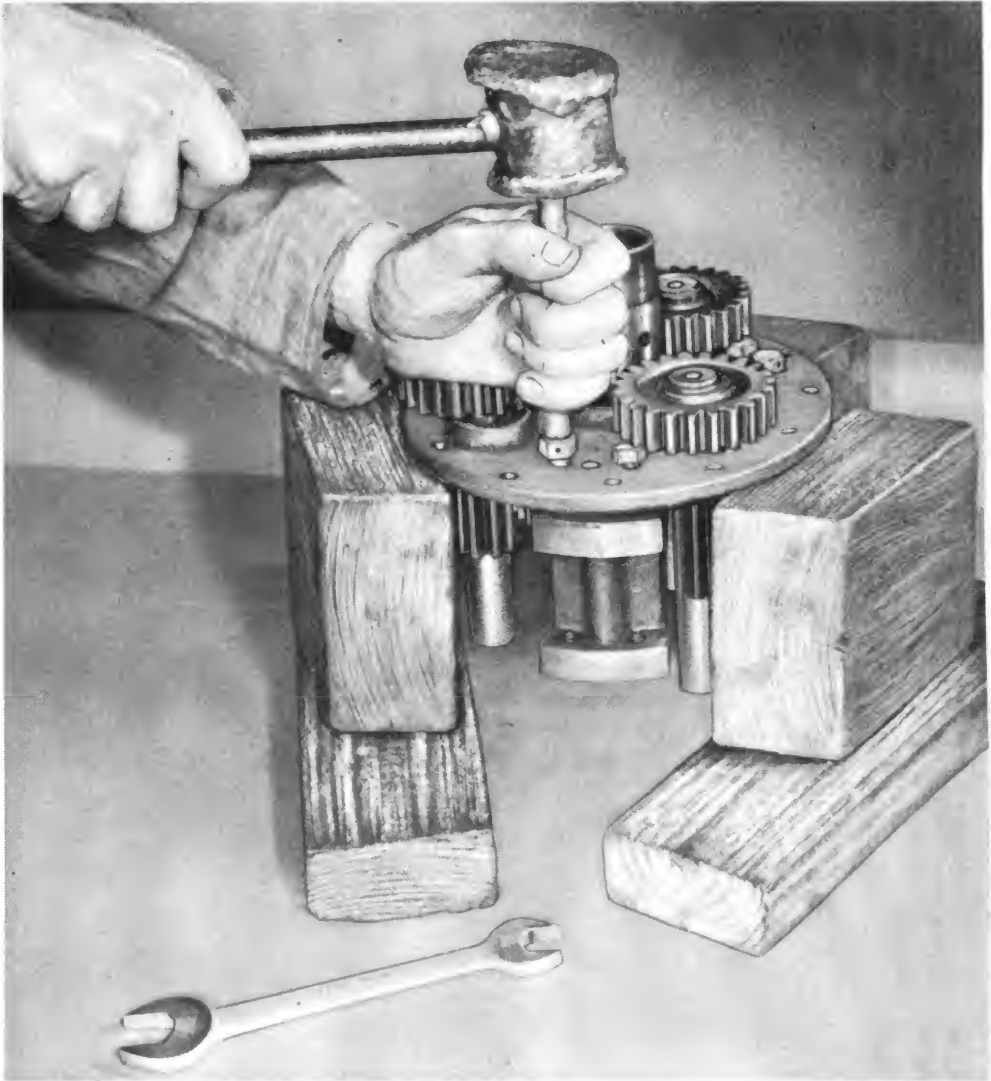
**Figure 59—Removing Right Differential Housing with Bevel Drive Gear, Planet Gears, and Pinions**

ings found to be unsatisfactory for further service (fig. 63). If necessary, remove differential axle shaft gear bushing from inner hub of housing, using cape chisel and hammer to collapse bushing at the split and remove it from hub bore. Install a new axle shaft gear bushing in inner hub of housing with final drive gear bushing replacer (41-R-2390-930) (fig. 64). Replace dowel pins if loose or broken.



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(4) **ASSEMBLE.** Install one of the planet pinions in the proper bore so that the end with the keyway and snap ring groove extends outside of differential housing. Place a Woodruff key in keyway of pinion and insert a cap screw into hole in housing adjacent to pinion, before installing planet gear. Place a planet gear on end of pinion (with hub extension

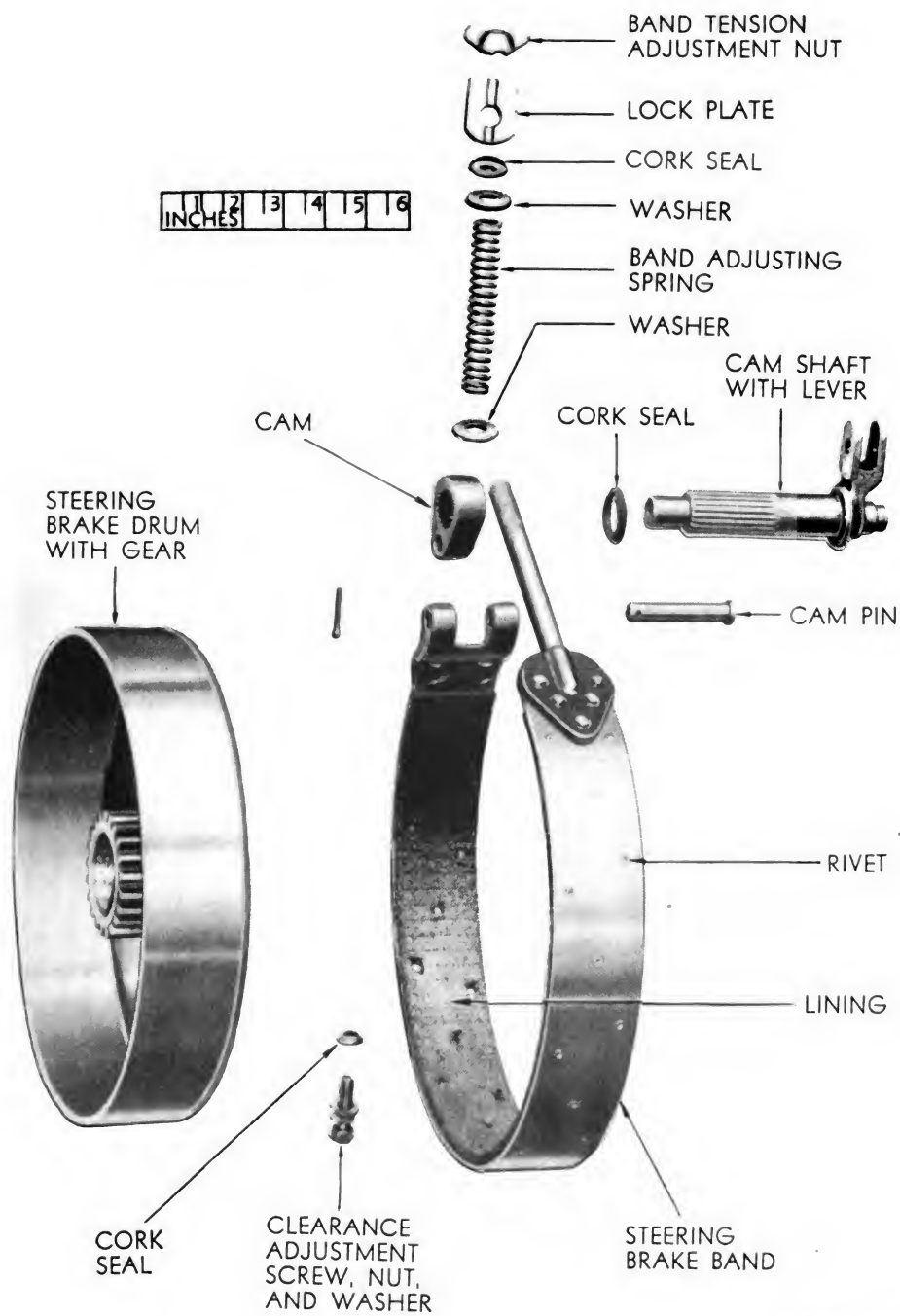


RA PD 66874

**Figure 60—Removing Left Differential Housing and Parts from Center Member**

toward housing) so keyway in planet gear is aligned with Woodruff key in pinion. Place a 0.010-inch feeler between gear hub and housing to assure proper clearance. Press gear on pinion shaft (fig. 65) until planet gear snap ring can be installed in snap ring groove with snap ring pliers. Repeat the procedure to install the other two planet pinions and gears.

AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY



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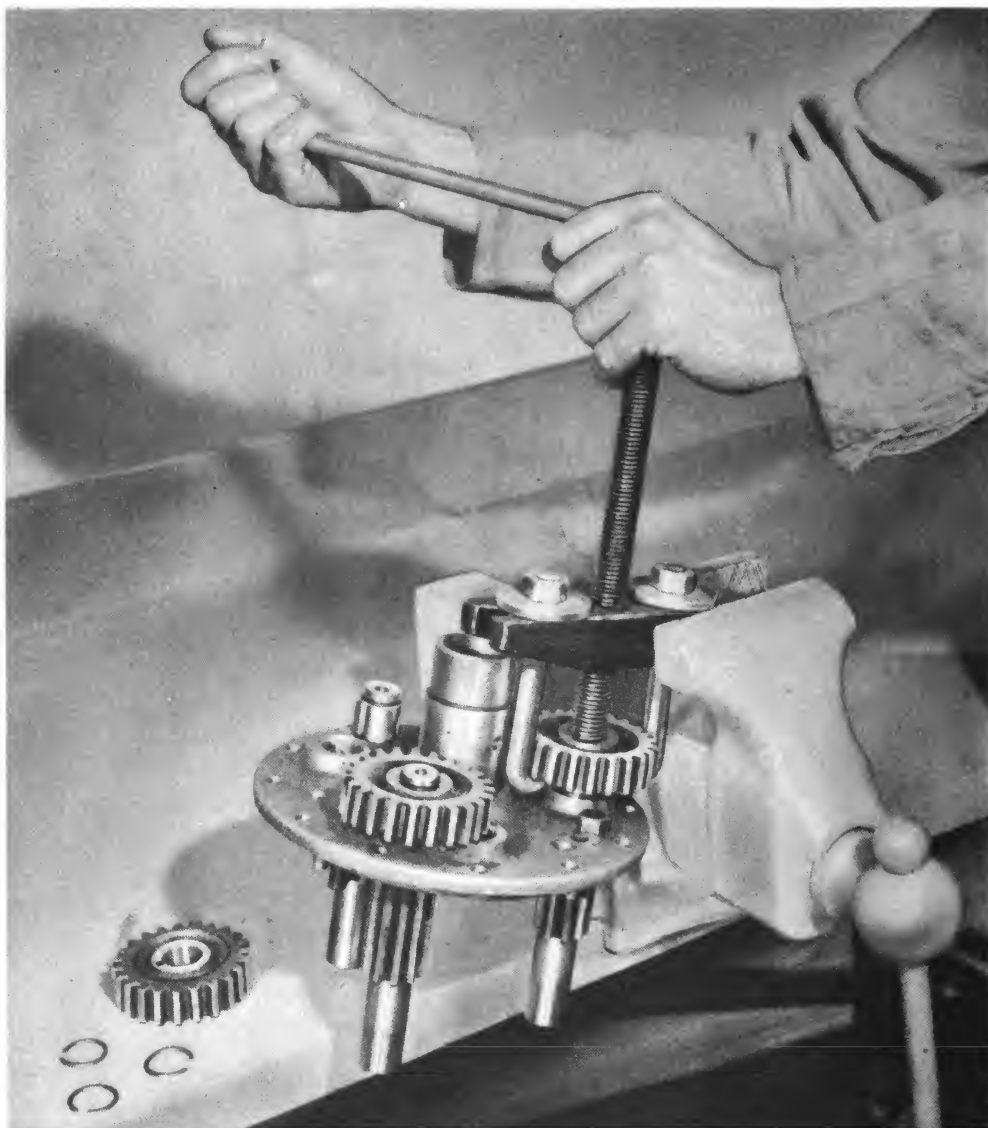
Figure 61—Parts of the Differential Steering Brake



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## e. Right Differential Housing, Planet Gears and Pinions, Bushings, and Bevel Drive Gears.

(1) **DISASSEMBLE.** Remove planet gear snap rings with snap ring pliers and screwdriver from outer ends of planet pinions. Pull each planet gear from its planet pinion, using universal puller (fig. 62). Re-



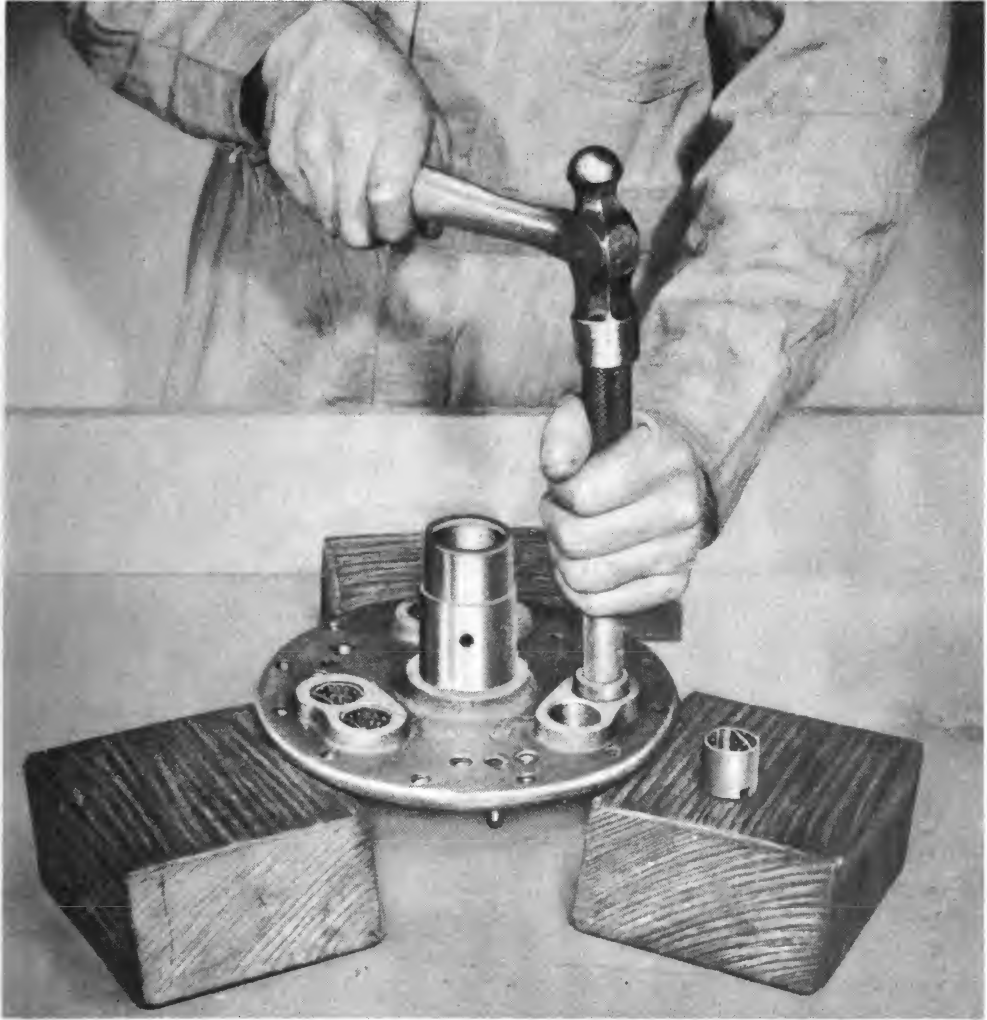
RA PD 66875

**Figure 62—Removing Planet Gears**

move Woodruff keys from keyways, and slide pinions out of housing after marking housing to indicate bore from which each pinion was removed. Remove locking wire from heads of bevel drive gear screws that secure bevel drive gear to housing. Take out screws and remove bevel drive gear from housing by tapping on outer portion of gear, if necessary, with a copper hammer (fig. 67).

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

(2) **INSPECTION.** Clean all parts in dry-cleaning solvent. Examine housing for cracks, scores, or other damage. Inspect planet gears and pinions for nicked or broken teeth, or other damage. Inspect the six planet pinion bushings and differential axle shaft gear bushing for looseness or damage. Examine bevel drive gear for breakage, for proper teeth bearing, galled teeth, or other damage.



RA PD 66877

**Figure 63—Removing Planet Pinion Bushings**

(3) **REPAIR.** If housing or hub is damaged or broken, replace it. Replace planet gears if teeth are nicked or damaged. If bushing contacting surfaces on planet pinions are damaged, and cannot be restored by smoothing with aluminum oxide abrasive cloth, or if pinion teeth are broken, replace pinions. Replace damaged Woodruff keys on reassembly, and install new planet gear snap rings. Replace any planet pinion bushings found to be unsatisfactory for further service. If necessary, remove differential axle shaft gear bushing from inner hub of housing,

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using a cape chisel and hammer to collapse bushing at the split, and remove it from hub bore. Install a new axle shaft gear bushing in inner hub of housing with final drive gear bushing replacer (41-R-2390-930). If bevel drive gear is unfit for further service, replace it. Replace dowel pins if loose or broken.



FINAL DRIVE GEAR BUSHING REPLACER 41-R-2390-930

RA PD 67267

**Figure 64—Installing Final Drive Shaft Gear Bushing**

(4) **ASSEMBLE.** Make sure that mating surfaces of bevel drive gear and housing are free from burs, grit, or other foreign matter. Place gear on housing so that cap screw holes in gear are alined with holes in housing. If necessary, tap gear until it is seated properly on housing, using a rawhide mallet. Install cap screws, tightening them alternately and progressively until secure. Lock cap screws with locking wire. Install one of the planet pinions in the proper bore so that end with keyway and snap ring groove extends outside of differential housing. Install a Woodruff key in keyway of pinion. Place a planet gear on end of pinion (with hub extension toward housing) so the keyway in planet gear is alined with Woodruff key in pinion. Place a 0.010-inch feeler between gear hub and housing to assure proper clearance. Press gear on pinion shaft (fig. 65) until planet snap ring can be installed in snap ring groove

## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

with snap ring pliers. Repeat the procedure to install the other two planet pinions and gears.

**f. Differential Side Bearings and Caps, Center Member, Axle Shaft Gears, and Axle Housing.**



RA PD 49474

**Figure 65—Installing Planet Gears on Pinions**

(1) **INSPECTION.** Examine bearing cones for scored or damaged rollers and excessive looseness of roller retainers. Check bearing cups for scores or damage. Inspect bearing caps for breakage or other damage. Examine center member for cracks or other damage and screw holes for stripped threads. Inspect axle shaft gears for scores or burs on machined surfaces, and nicked or damaged teeth. Inspect axle housing for breakage or other damage.

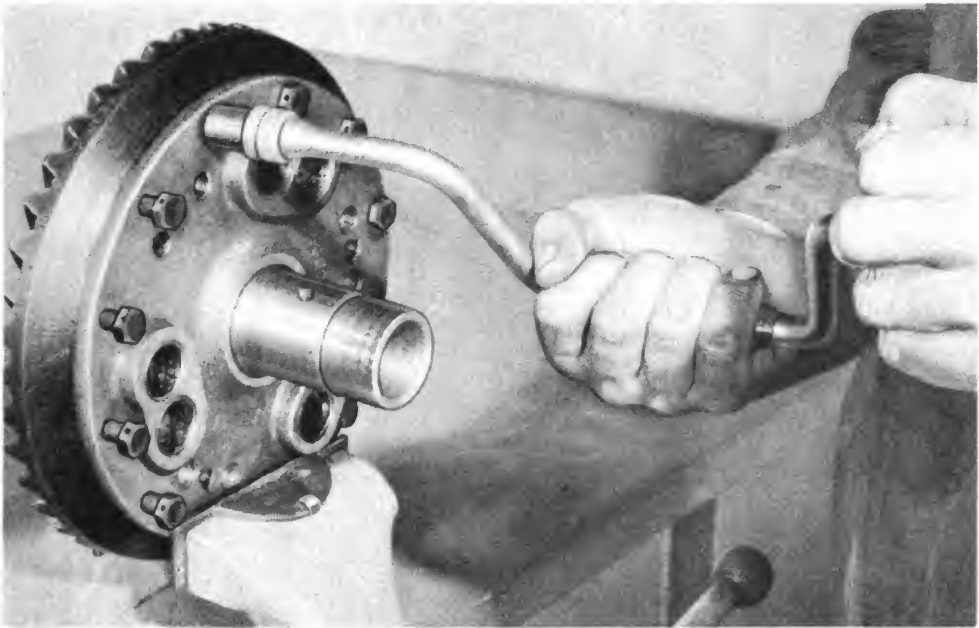


## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

(2) **REPAIR.** If bearing cones or cups are found to be unfit for further service, replace them. Replace bearing caps if they are broken, or otherwise damaged. If the center member, or axle shaft gears, are unsatisfactory for further service, replace them. If axle housing is broken or damaged, and cannot be made serviceable by welding or machining, replace it.

### 34. ASSEMBLY OF AXLE DIFFERENTIAL.

a. **Install Left Differential Housing with Planet Gears and Pinions, and Left Axle Shaft Gear on Center Member.** Set center member on a bench with three of the drilled sectors up and place left axle shaft



RA PD 49472

**Figure 67—Removing Bevel Drive Gear**

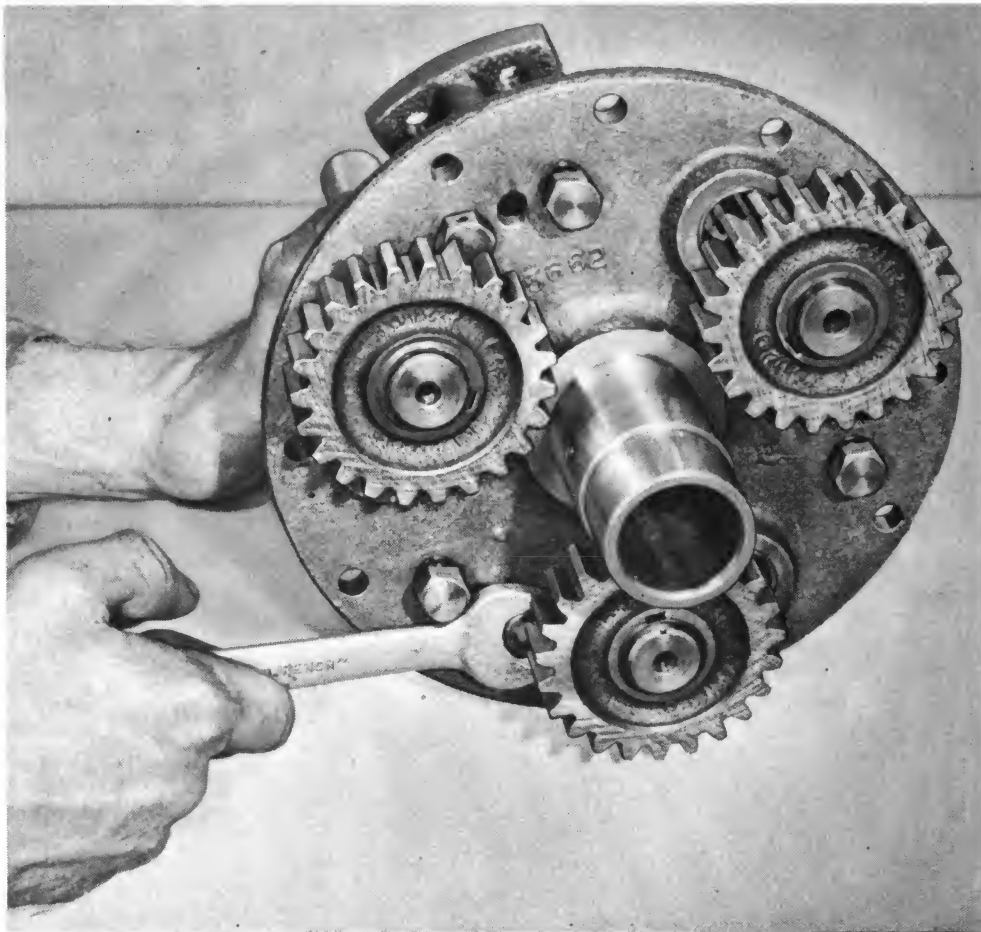
gear into position in hub of center member. With hub of the left differential housing assembly up, turn planet gears so that keyways all point to center of hub (fig. 68). The keyways must be alined in this manner or the differential will lock, due to the difference in tooth pitch on the various meshing gears, if they are not in proper engagement with each other. Lift differential housing assembly and set it over center member so the cap screw holes in housing are alined with mating holes in center member and pinion teeth mesh with the teeth on left axle shaft gear. Install the three remaining cap screws, tighten all six cap screws alternately and progressively, starting with the screws under the planet gears. Tap on housing as required over dowels only, with a brass drift and a hammer to assist in seating left housing with dowels



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against center member. Tighten cap screws securely and lock each pair with locking wire.

b. Install Right Differential Housing with Bevel Drive Gear, Planet Gears and Pinions, and Right Axle Shaft Gear on Center Member. Place left differential housing assembly with center member



RA PD 66876

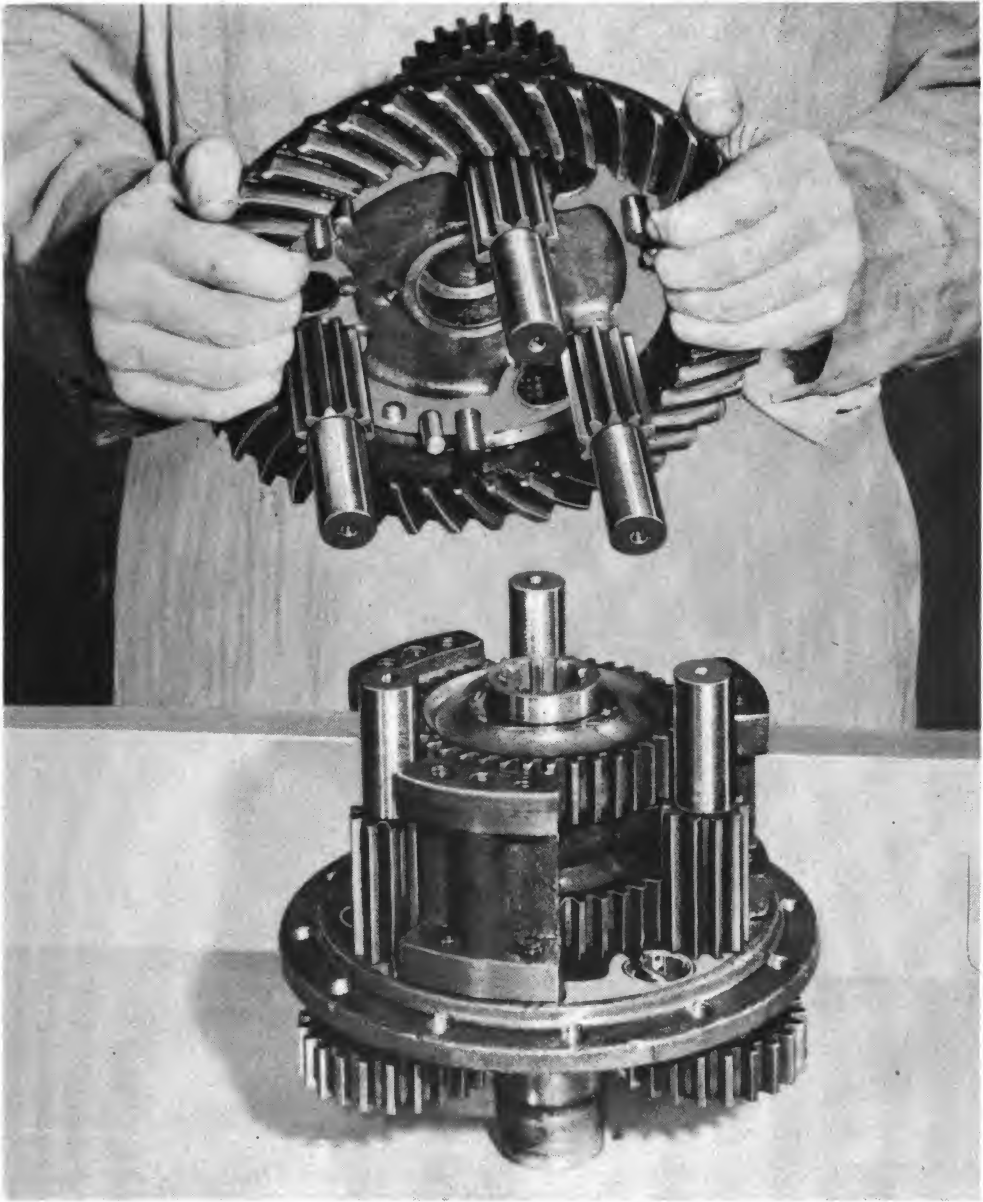
**Figure 68—Assembling Left Housing with Planet Gears and Pinions to Center Member**

on bench so that it sets on housing hub. (Make sure the keyways in the planet gears on the left housing still point to the center of the hub.) Place right axle shaft gear into position in hub of center member. With hub of right differential housing assembly up, turn planet gears so that the keyways all point to hub center. **CAUTION:** *The differential will lock if the various meshing gears, which have differences in gear tooth pitch, are not in proper engagement.* Lift the right differential housing assembly, and set it over the center member (fig. 69) so that the cap screw holes in the housing are alined with the mating holes in the



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

center member. Turn the three planet gears on right housing slightly, in the same direction, so that the planet pinions will mesh with right axle shaft gear and planet pinions in left housing. Install and tighten the six cap screws in the right housing. Tap on housing, as required,



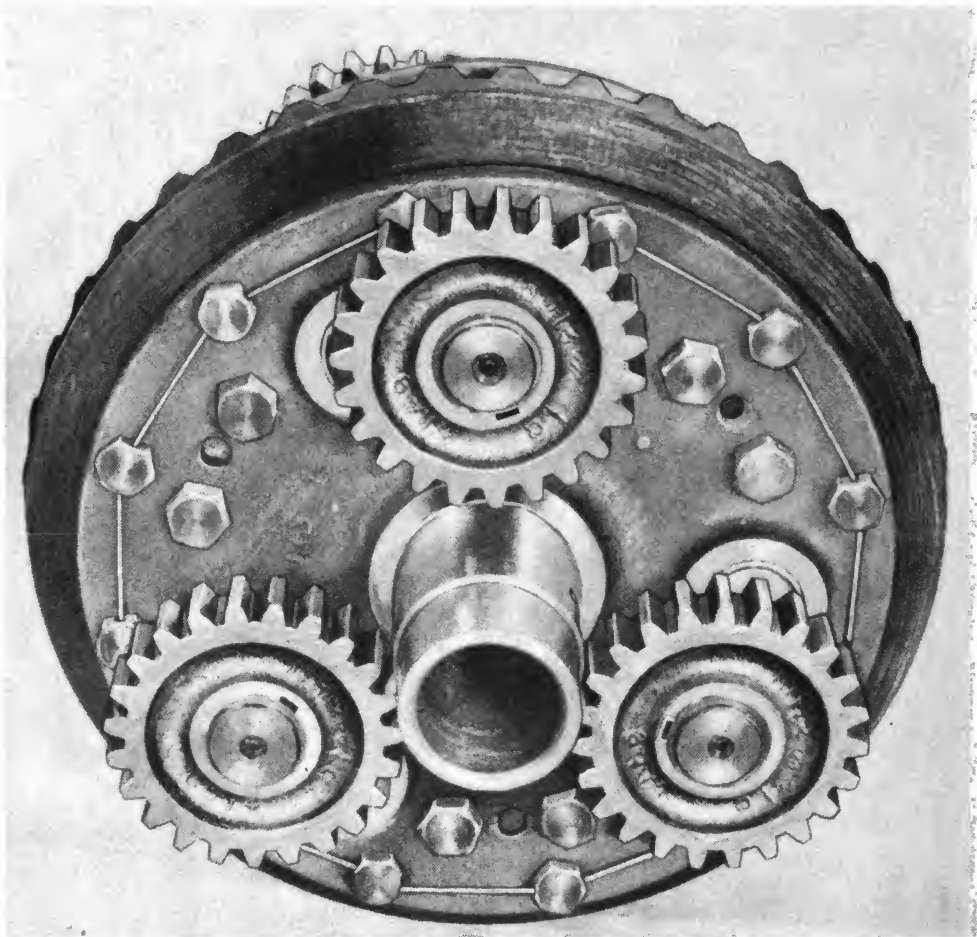
RA PD 66878

**Figure 69—Assembling Right Housing with Parts to Center Member and Left Housing**

over the dowels only, with a brass drift and hammer, to assist in seating right housing with dowels against center member. Turn planet gears by hand to make certain all gears operate freely and differential does not lock. Tighten cap screws securely and lock each pair with locking wire (fig. 71).

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

c. **Install Steering Brake Drums.** With keyways in all planet gears pointing to center of hubs, set one drum with gear in place over left housing hub and install snap ring spacer, using snap ring pliers. Repeat the procedure to install the other drum with gear. Drive one of the differential side bearing cones into position on right housing hub with numbered side toward housing (fig. 72). Repeat the procedure to install the other bearing cone on left housing hub.



RA PD 49462

***Figure 70—Right Housing with Parts Assembled to Center  
Member and Left Housing***

d. **Install Steering Brake Bands.** With bevel drive gear on the right side, place brake bands over drums so that adjusting studs are at top of drums and extend rearward.

**35. DISASSEMBLY, INSPECTION, REPAIR, AND ASSEMBLY OF  
AXLE TRANSMISSION.**

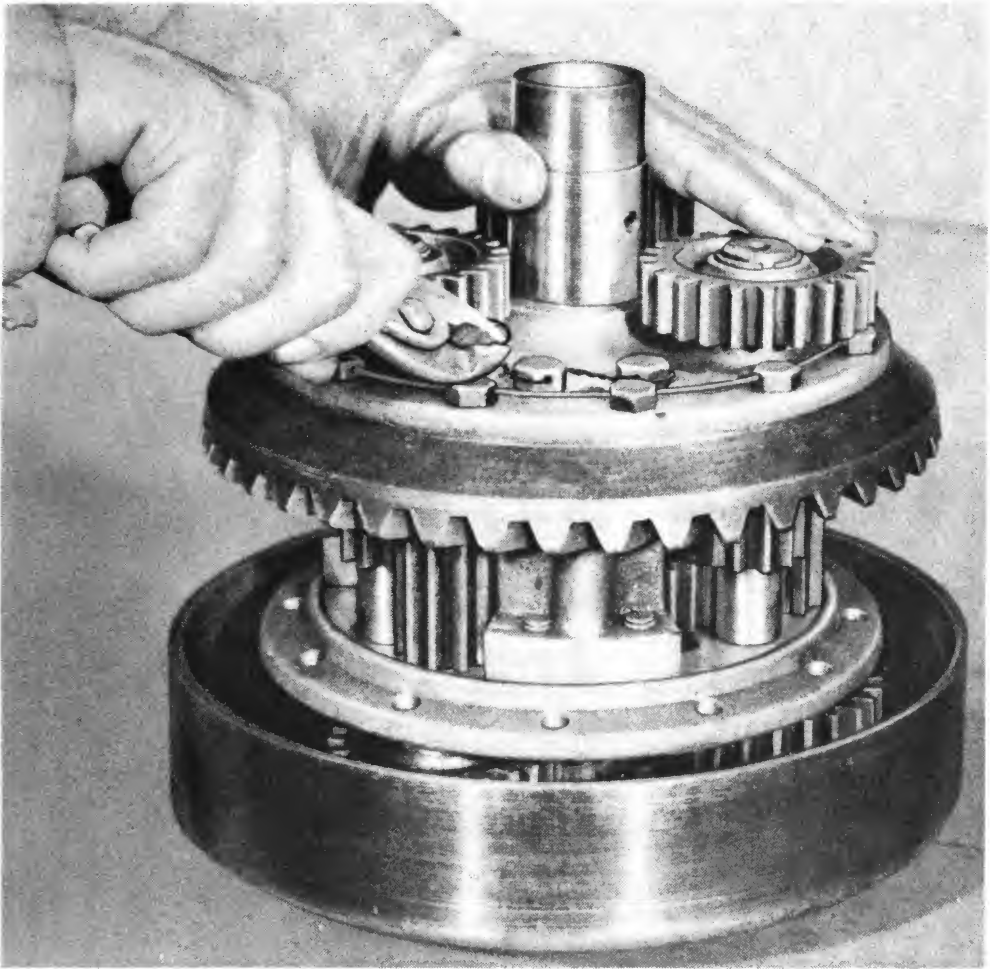
a. **General.** The disassembly, cleaning, inspection, repair, and re-assembly of the various subassemblies must be performed with care

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

and cleanliness. To avoid confusion or error, treat such subassembly as a unit. Mark certain related parts before disassembly, to aid in subsequent assembly operations. Carefully clean each component after disassembly. Inspect the various parts carefully and thoroughly, to determine their fitness for further service.

**b. Shift Cover Assembly.**

(1) **DISASSEMBLE.** Drive out lock pin that secures the front end of shift rod to shift cover. Drive shift rod out the front bore in cover with



RA PD 49461

**Figure 71—Installing Lock Wire**

a brass drift and hammer, being careful not to lose shift rod lock ball released from recess in shift fork. Remove shift lever lock bolt with nut and lock washer. Drive against outer end of shift arm shaft while holding shift lever, to remove lever from arm shaft, using a brass drift and hammer. Remove Woodruff key from end of shift arm shaft and pull arm out of cover.

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(2) **INSPECTION.** Clean all parts in dry-cleaning solvent. Inspect the shift rod and ball notches for burs, or evidence of damage. Check shift arm for alinement or damage. Inspect shift fork sliding gear contacting surfaces and shift rod bearing surface for burs, scores, and alinement



RA PD 67191

**Figure 72—Installing Differential Side Bearing Cone**

of shift fork. Check ball tension spring for damage. Examine shift rod lock ball for scores or damage. Examine shift cover bores for scores or other damage.

(3) **REPAIR.** Where possible, remove any burs or rough places on the parts. Replace any parts which cannot be made serviceable. Use a new cork oil seal on reassembling, to minimize the possibility of leakage at this point.

AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

RA PD 6688

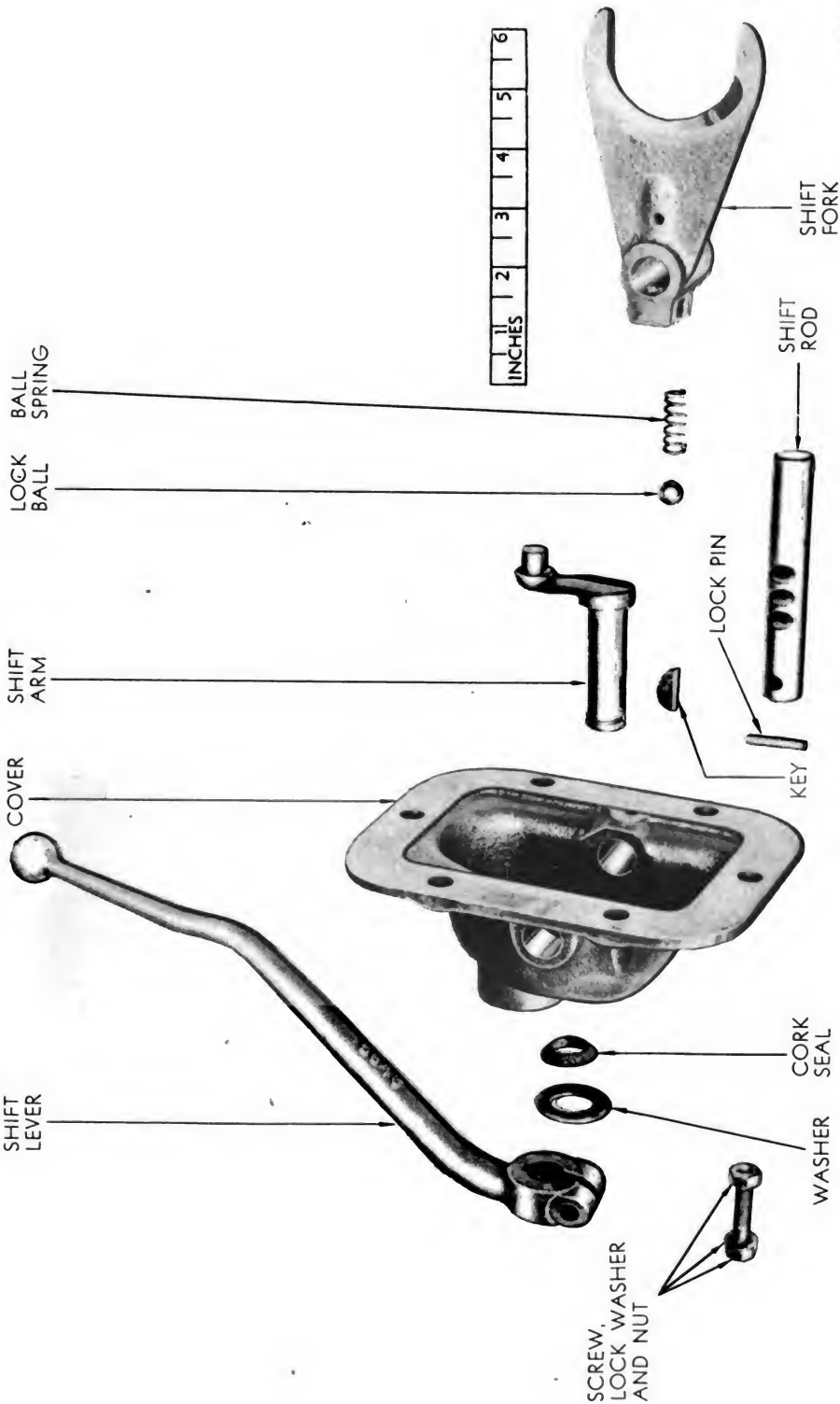


Figure 73—Axle Transmission Gearshift Mechanism



**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

(4) **ASSEMBLE.** Place cover in a vise having copper jaws so that the shift rod lock pin hole is at the bottom, and install shift arm in cover. Insert the ball tension spring in recess in shift fork. Hold shift fork with hub extension up, so that rod bore in fork is in alinement with



RA PD 49451

**Figure 74—Installing Shift Rod in Cover and Shift Fork**

shift rod bore in cover, and engage fork with shift arm lug. Start un-drilled portion of shift rod up through the cover lower bore with ball notches toward spring recess and through the fork bore. Place lock ball into shift fork hub; resting it on end of shift rod, press lock ball into



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

spring recess in shift fork; at the same time tap lower end of shift rod through fork and into cover upper bore (fig. 74). Aline the shift rod lock pin hole with the holes in the cover and install the lock pin, and tap into place. Install a new cork oil seal over the outer end of the shift arm shaft. Install the Woodruff key in the keyway, and tap the shift



RA PD 49455

**Figure 75—Removing Pinion Low Speed Gear Bearing Sleeve and Thrust Washer**

lever into position on the shift arm shaft. (The bend of the shift lever must be toward the cover.) Install the shift lever lock bolt, lock washer, and tighten the nut securely.

**c. Pinion Rear Bearing Cap Assembly.**

(1) **DISASSEMBLE.** Loosen the speedometer pinion sleeve if not loosened previously and remove the sleeve from the axle transmission pinion rear bearing cap. Lift the speedometer pinion out of the cap.



**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

(2) **INSPECTION AND REPAIR.** Clean all parts in dry-cleaning solvent. Inspect the teeth on the pinion gears for chipping, burs, or other damage. Examine the pinion shaft for scores or damage. Inspect the pinion pilot bushing within the cap and the pinion sleeve nut which supports the other end of the pinion. If any damage cannot be repaired by machining or dressing down burs, replace parts as required.



RA PD 67264

**Figure 76—Removing Pinion Inner Bearing Cone**

(3) **ASSEMBLE.** Install the speedometer pinion in the bearing cap so the pinion pilot enters the pilot bushing. Install the pinion sleeve.

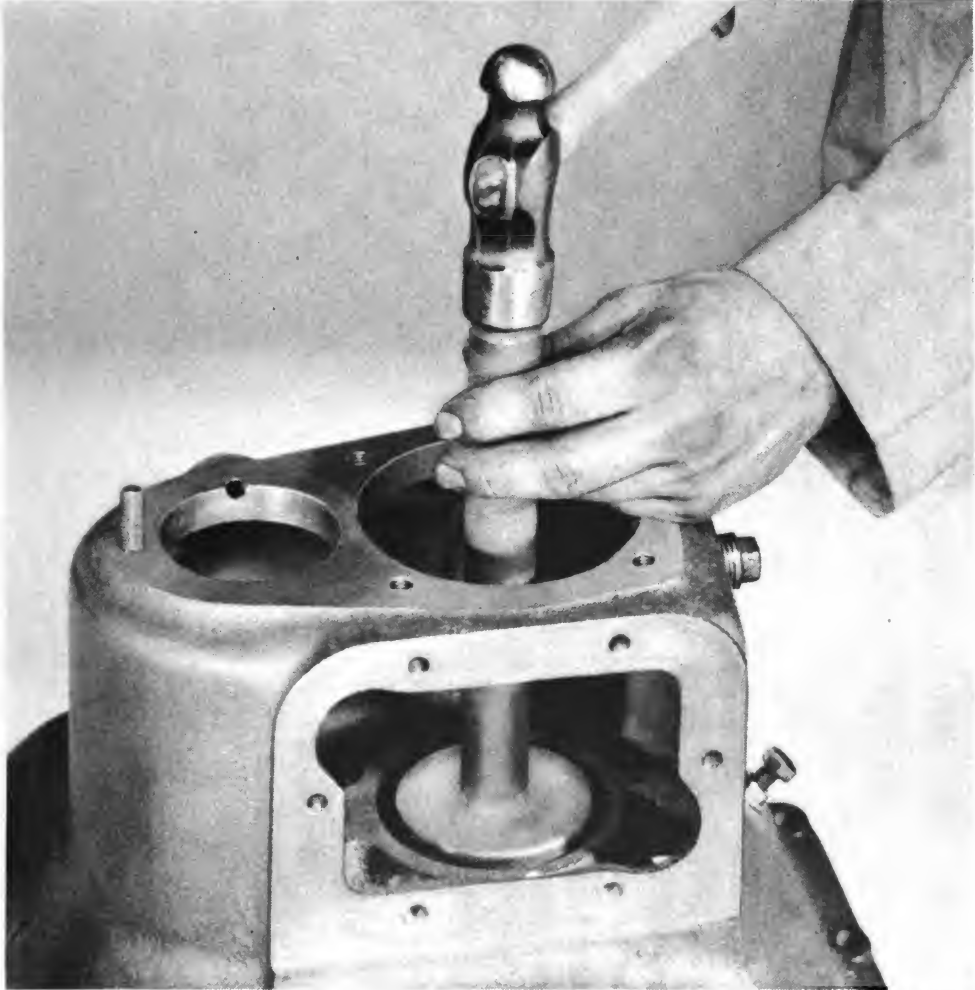
**d. Pinion, Bearings, and Gears.**

(1) **DISASSEMBLE.** Drive against pinion thrust washer with a brass drift and hammer to remove pinion low gear bearing sleeve with pin and thrust washer from pinion shaft (fig. 75). Slip low gear spacer off pinion shaft. Remove pinion front bearing cone from pinion shaft (fig. 76). If necessary, the pinion front bearing cup may be removed by driving it forward out of case (fig. 77). If front bearing cup snap

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

ring is broken, remove pieces and install a new ring. The pinion rear bearing cup may be removed from axle transmission rear cover plate by driving it out the rear of cover plate (fig. 78). If rear bearing cup snap ring is broken, remove pieces and install a new ring.

(2) **INSPECTION.** Clean all parts in dry-cleaning solvent. Examine low speed gear bearing sleeve outer surface for scores, or other damage.



RA PD 67173

**Figure 77—Removing Pinion Inner Bearing Cup**

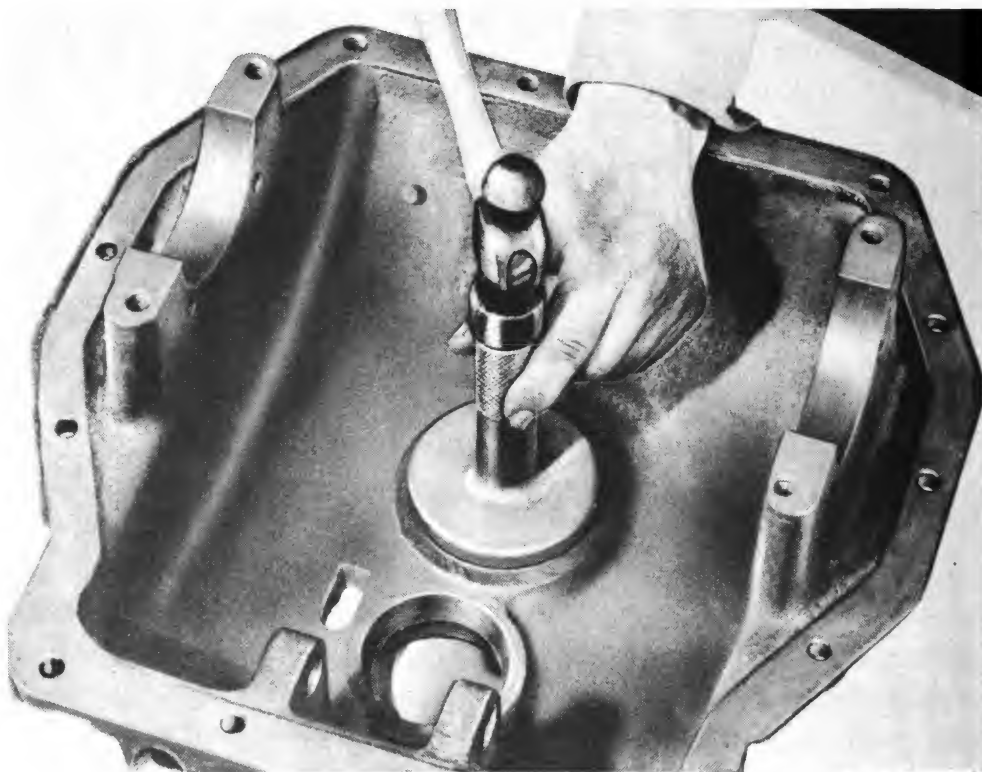
Check sleeve lock pin to make sure it is in a serviceable condition. Note condition of thrust washer and spacer. Examine pinion shaft carefully for damaged keyway or threads at the rear end, burs on high speed gear bearing rollers surface, damaged splines, broken, chipped, or damaged pinion teeth. If pinion front and rear bearing cups were removed, examine races for scoring, chipping, or other damage. Inspect high speed gear and low speed gear teeth for chipping or other damage; examine bearing roller race in hubs of gears for galled or damaged condition.

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HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**



RA PD 67145

**Figure 78—Removing Pinion Outer Bearing Cup**



RA PD 67266

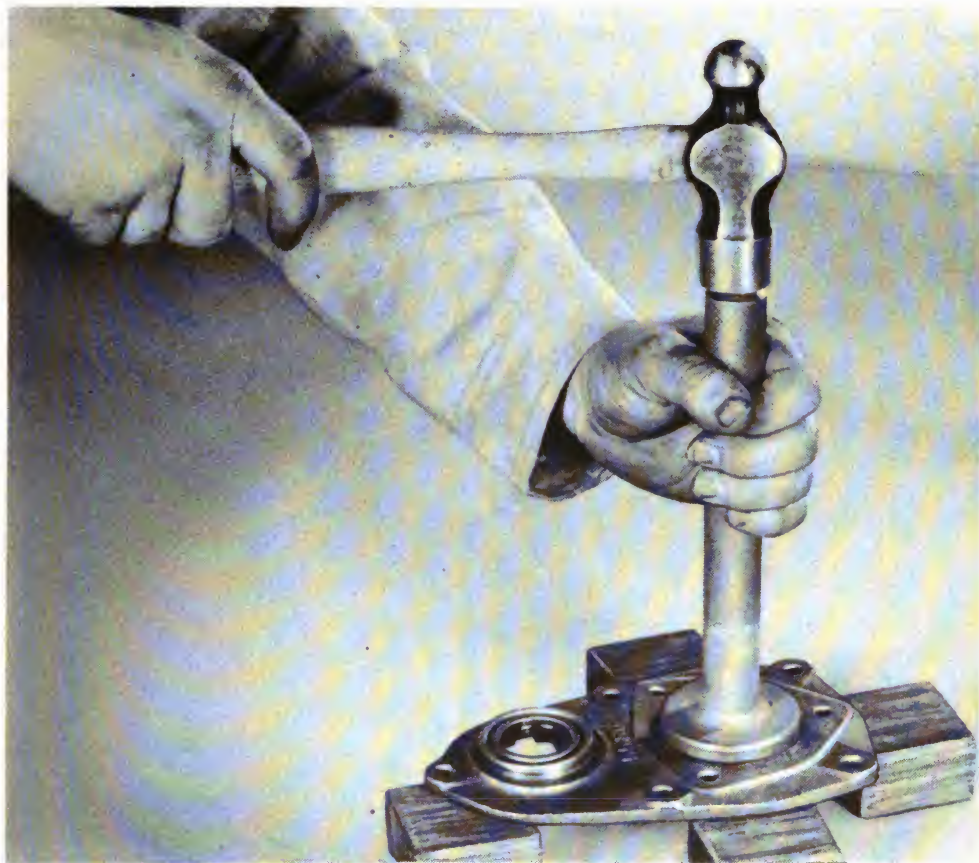
**Figure 79—Installing Pinion Inner Bearing Cup**



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

Inspect the two sets of bearing rollers for scores or other damage. Check sliding gear teeth and splines for chipping, burs, or other damage.

(3) **REPAIR.** If pinion and parts are found to be unserviceable, or cannot be made serviceable by dressing or machining any rough portions, replace parts as required. If the spring washer, thrust washers,



RA PD 67192

**Figure 80—Installing Pinion Outer Bearing Cup**

Woodruff key, and locating washers are unserviceable, replace them during reassembly. Install new snap rings and a pinion rear bearing adjusting nut on reassembly.

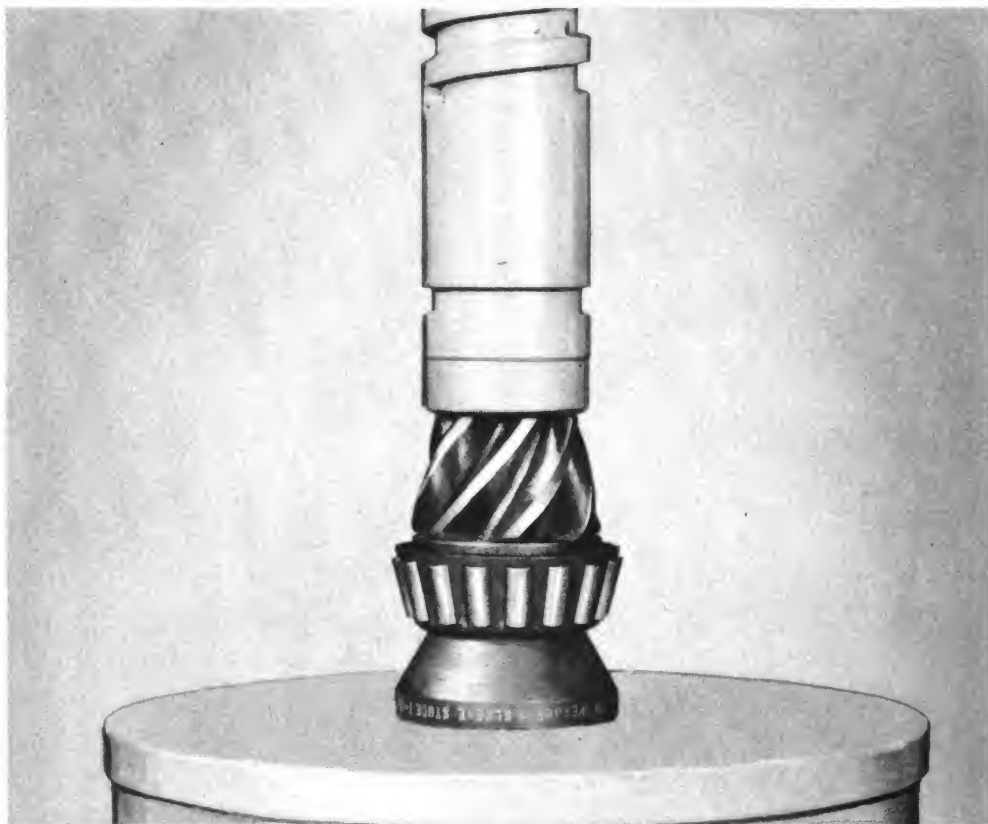
(4) **ASSEMBLE.** If pinion front and rear bearing cups were removed and found to be unserviceable, install new pinion front bearing cup with numbered side toward snap ring in case (fig. 79), and rear bearing cup with numbered side next to snap ring in cover plate (fig. 80). Press

# **ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

pinion front bearing cone on pinion shaft with numbered side next to pinion gear (fig. 81). Install low gear spacer and thrust washer on pinion shaft. Place low gear bearing sleeve and lock pin, with pin nearest rear end of pinion shaft, and drive sleeve into place against thrust washer. The lock pin must go between two of the splines.

## **e. Mainshaft, Bearings, and Gears.**

(1) **DISASSEMBLE.** If necessary, mainshaft rear bearing cone may be pressed off rear end of mainshaft, after removing snap ring with snap



RA PD 67134

**Figure 81—Installing Pinion Inner Bearing Cone**

ring pliers (fig. 83). The mainshaft front bearing cup may be removed by driving out through rear of case (fig. 84). The mainshaft front bearing oil cup may be driven out the front of the case, if necessary, using a  $1\frac{7}{8}$ -inch arbor and hammer (fig. 85). If the front bearing cup snap ring is broken, remove pieces and install a new ring. If leakage has occurred at rear end of mainshaft, and inspection reveals that a new oil seal is required, remove seal from transmission rear cover by driving out of cover (fig. 86).

# AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

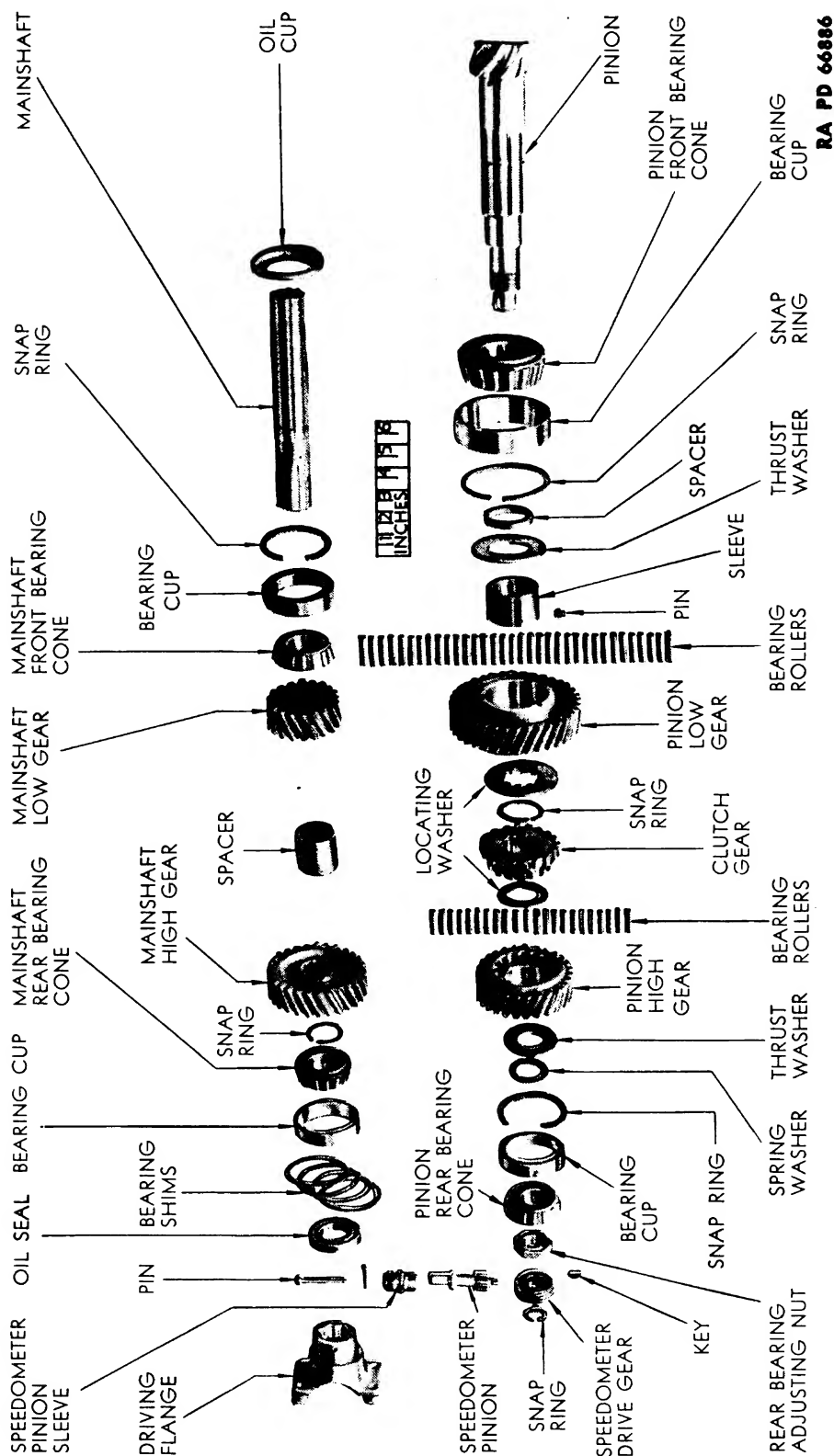
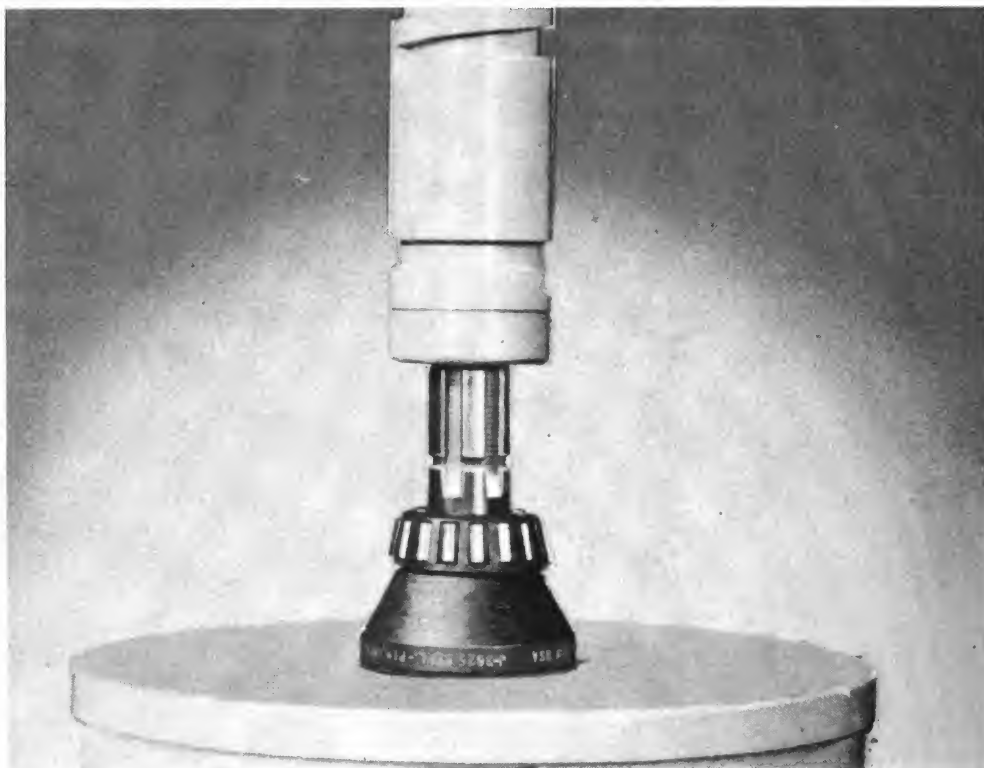


Figure 82—Axle Transmission Parts

RA PD 66886

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**



RA PD 67265

**Figure 83—Removing Mainshaft Outer Bearing Cone**



RA PD 67263

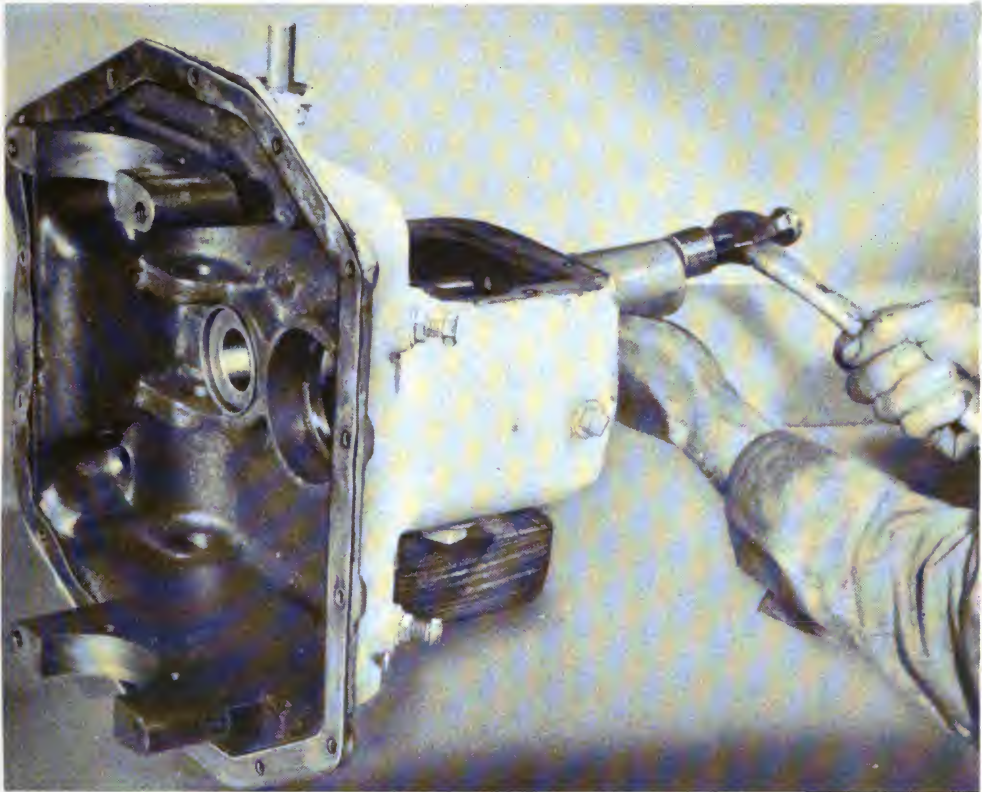
**Figure 84—Removing Mainshaft Inner Bearing Cup**



## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

(2) **INSPECTION.** Immerse all parts in dry-cleaning solvent and wipe dry with clean cloth. Check rear bearing and front bearing cones for rough or damaged rollers. Inspect mainshaft splines for burs or damage. Inspect mainshaft low and high speed gears for chipped teeth and damaged splines. Inspect gear spacer for possible damage. Examine front and rear bearing cups for cracks, or damaged races.

(3) **REPAIR.** If mainshaft and parts are found to be unserviceable, or cannot be made serviceable by dressing or machining any rough portions, replace parts as required.



RA PD 49447

**Figure 85—Removing Mainshaft Inner Bearing Oil Cup**

(4) **ASSEMBLE.** If mainshaft oil seal was removed, drive a new seal into rear cover, so that flat side is toward the inside and to within one-eighth inch of rear cover inner surface (fig. 87). If mainshaft front bearing oil cup was removed, install a new cup in case with extended edge forward, so that it is flush with case, using a  $2\frac{1}{8}$ -inch arbor and hammer (fig. 88); if removed previously, install a new mainshaft front bearing cup (fig. 89). Install a new snap ring on mainshaft with snap ring pliers. Install new mainshaft rear bearing cone with numbered side against snap ring (fig. 90).

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f. **Case and Driving Flange.** Inspect case for cracks or other damage. If case is unsatisfactory and cannot be made serviceable by welding or machining, replace it. Refer to paragraph 17 e (2) for instructions covering the driving flange.

**36. ASSEMBLY.**

a. **Install Axle Transmission Mainshaft, Bearings, and Gears.** Apply SAE 10 engine oil to all parts before or during assembly. Insert



RA PD 49448

**Figure 86—Removing Mainshaft Oil Seal**

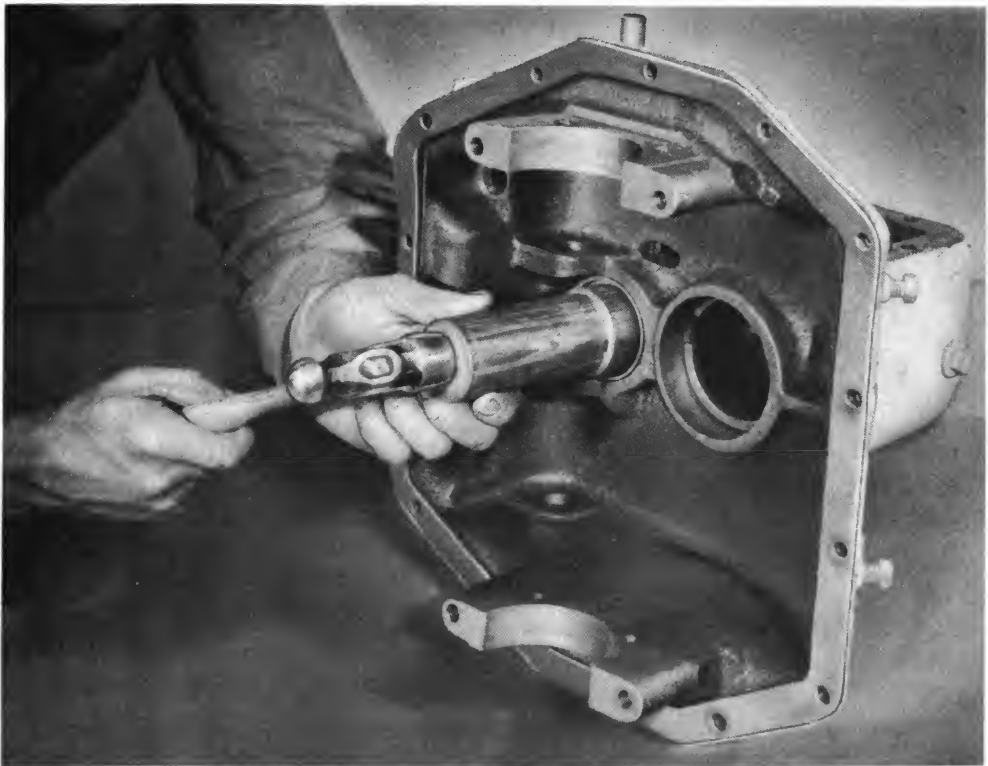
front end of mainshaft with rear bearing cone assembled, through mainshaft rear bearing bore in case, and slide mainshaft high speed gear onto mainshaft with hub extension toward front. Slide spacer, and then mainshaft low speed gear, onto mainshaft with hub extension of gear toward rear. Place mainshaft front bearing cone into cup and enter front end of shaft into front bearing cone. Tap lightly on rear end of mainshaft to start mainshaft into front bearing cone. Revolve mainshaft to make certain that it is started straight into front bearing cone. Press mainshaft into position with an arbor press and hollow mandrel. Install mainshaft rear bearing cup (fig. 91), and install sufficient quantity of

**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**



RA PD 67144

**Figure 87—Installing Mainshaft Oil Seal**



RA PD 49446

**Figure 88—Installing Mainshaft Inner Bearing Oil Cup**



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shims at rear of cup to provide a shim pack that is flush with rear face of axle transmission case.

b. **Install Axle Transmission Pinion, Bearings, and Gears.** Apply SAE 10 engine oil to all parts before or during assembly. Insert low speed gear into case through shift cover opening with internal teeth toward rear. Install pinion shaft rear end through front bearing cup and



RA PD 67163

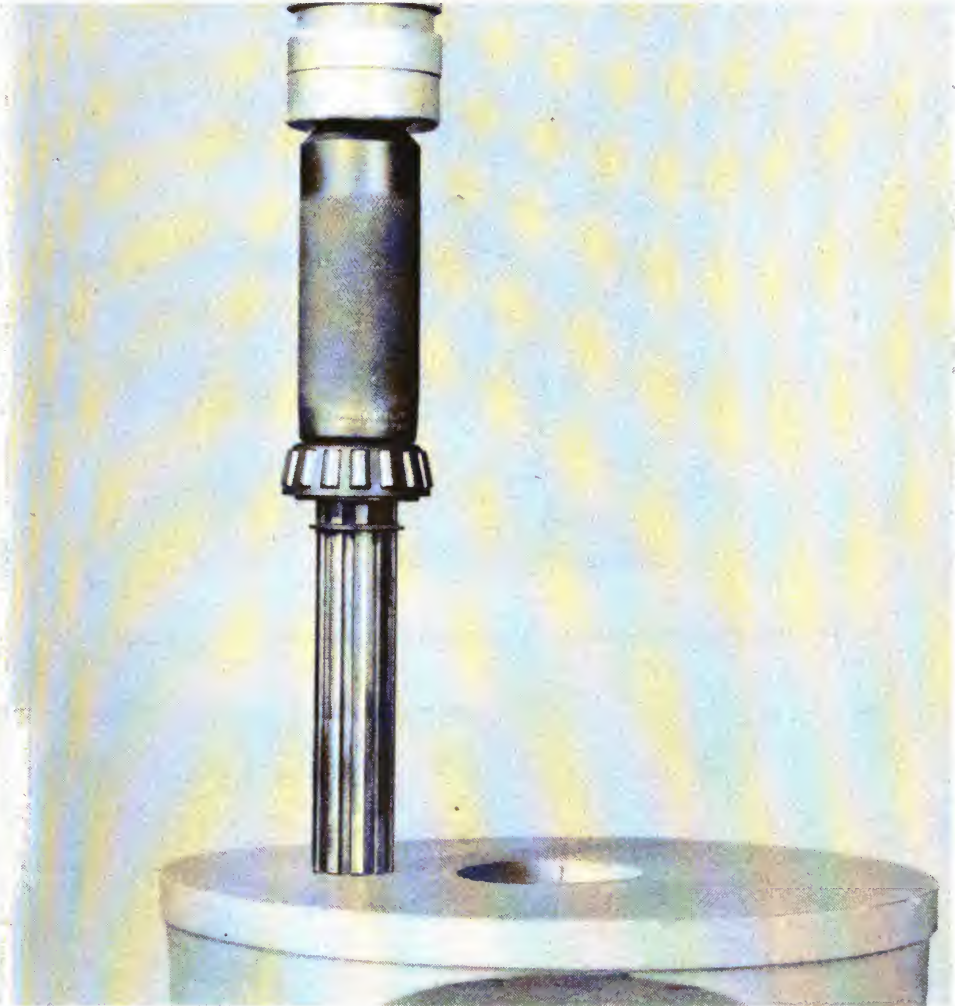
**Figure 89—Installing Mainshaft Inner Bearing Cup**

low speed gear bore. Block up under pinion and insert the 34 bearing rollers between low speed gear bore and pinion shaft low gear sleeve (fig. 92). Install bearing rollers, locating washer over end of pinion shaft, and tap into position. Start a new snap ring over pinion splines with snap ring pliers, and tap the ring downward (fig. 93) until it enters groove in pinion shaft. Install sliding gear on pinion shaft so that the teeth on large end of gear mesh with the internal teeth in low speed



## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

gear. Install high speed gear bearing rollers, locating washer and high speed gear on pinion shaft with the internal teeth of gear toward sliding gear. Insert the 22 high speed gear bearing rollers (fig. 94) and place thrust washer on pinion shaft against gear hub. Install spring washer on pinion shaft.

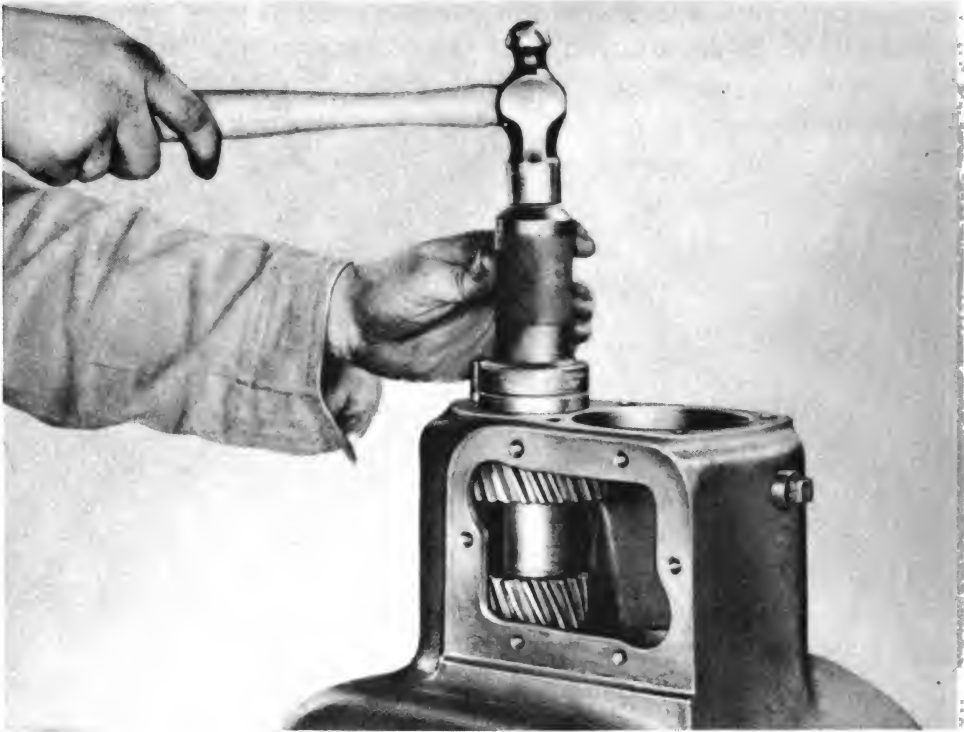


RA PD 67068

**Figure 90—Installing Mainshaft Outer Bearing Cone**

c. **Install Axle Transmission Case Rear Cover Plate.** Place transmission case rear cover plate gasket in position, and install mainshaft rear bearing shims. Install transmission case rear cover plate, using a piece of shim stock around splines on mainshaft, to avoid damaging oil seal leather (fig. 95). Install the four cap screws and one nut with lock washers, and tighten securely. Place pinion rear bearing cone over the end of the pinion and drive it into position (see fig. 96). Install pinion end play adjusting nut and tighten until pinion can be turned slightly with thumb and forefinger. Stake the nut securely into groove in pinion shaft (fig. 97). Install speedometer drive gear Woodruff key

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RA PD 67272

**Figure 91—Installing Mainshaft Outer Bearing Cup**

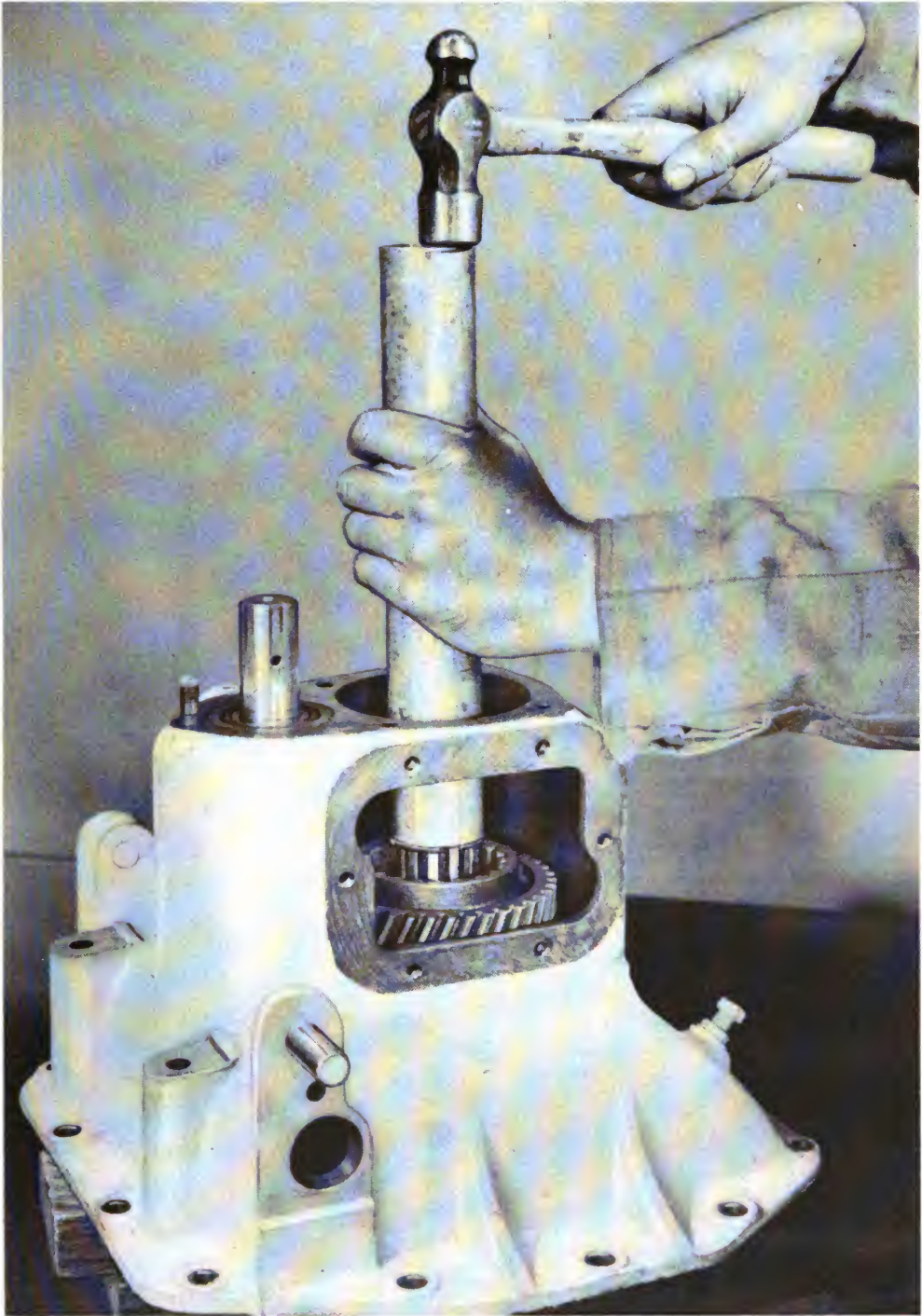


RA PD 67268

**Figure 92—Installing Pinion Low Speed Gear Rollers**



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**



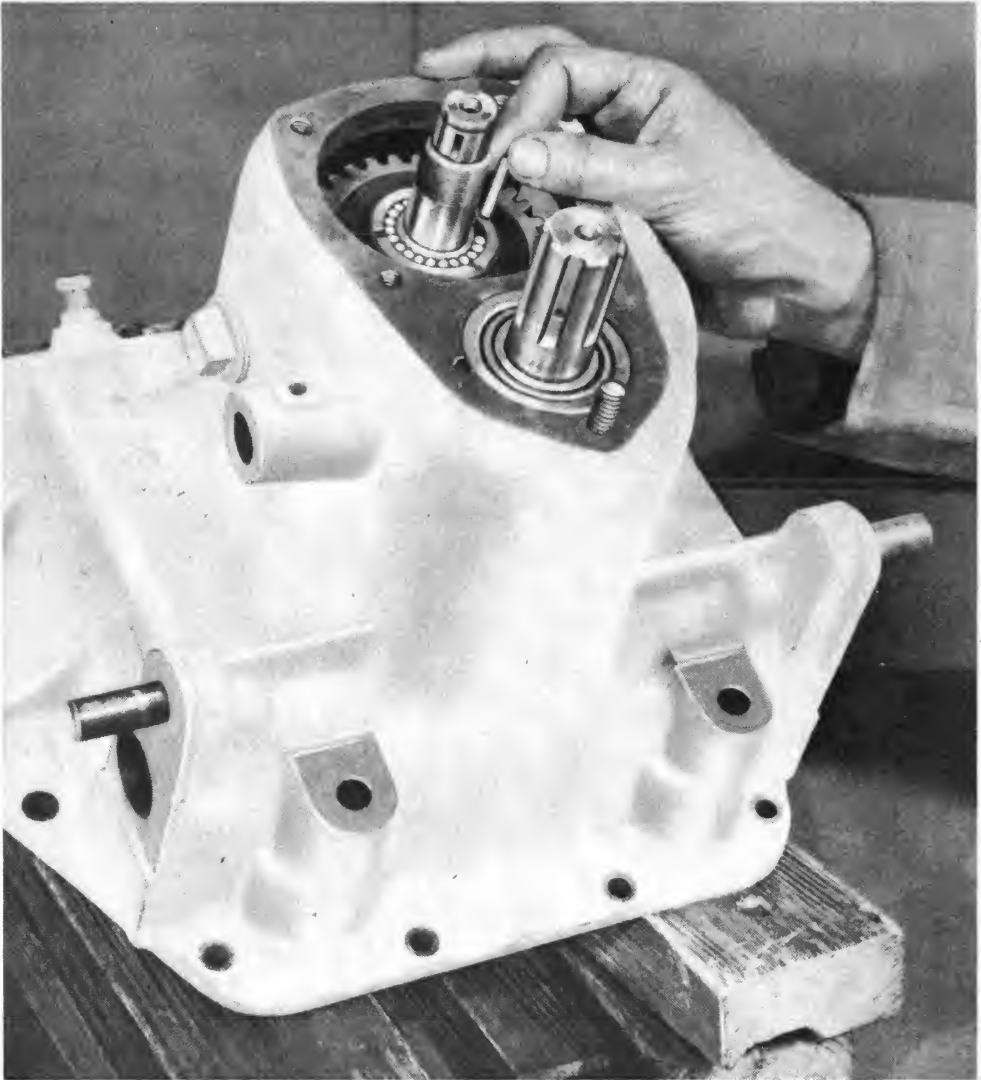
RA PD 49468

**Figure 93—Installing Pinion Low Speed Gear Snap Ring**

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

and gear, with numbered side toward rear. Install speedometer drive gear snap ring with snap ring pliers.

d. **Install Axle Transmission Pinion Rear Bearing Cap Assembly.** Install pinion rear bearing cap with new gasket. Install the three cap



RA PD 49465

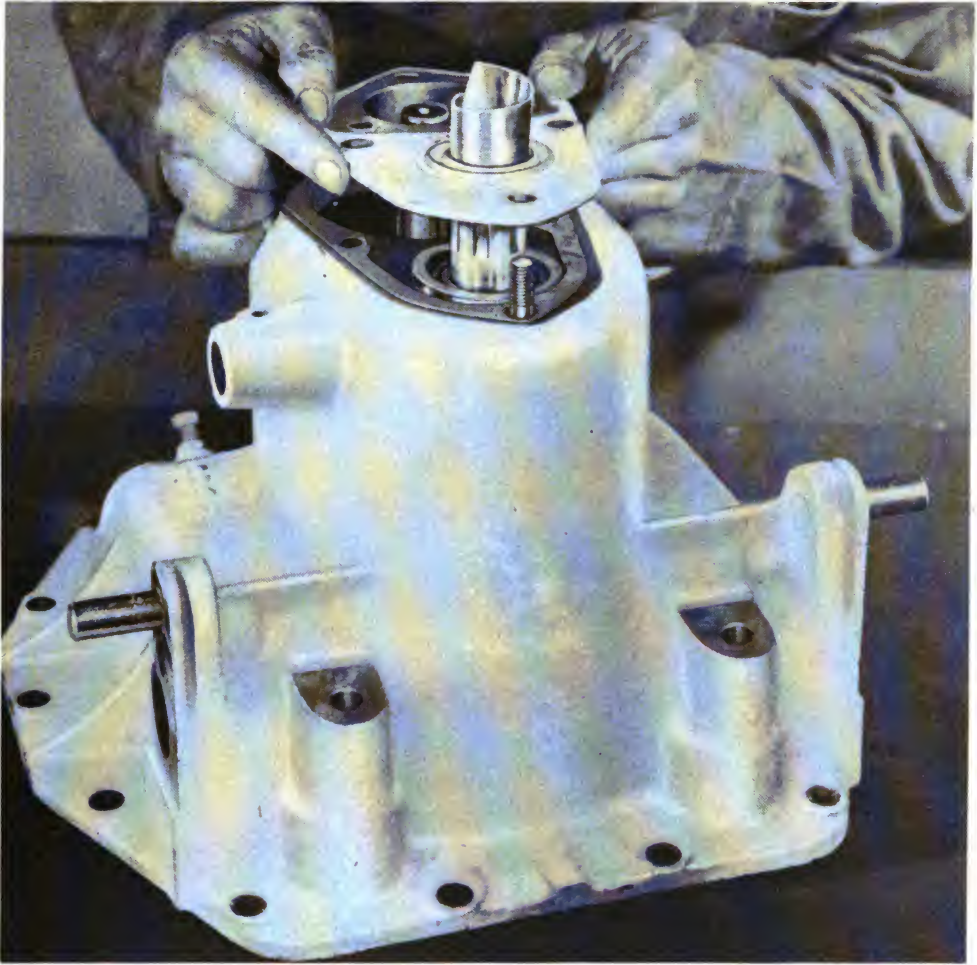
**Figure 94—Installing Pinion High Speed Gear Bearing Rollers**

screws and lock washers, and tighten securely. Tighten speedometer pinion sleeve securely.

e. **Install Axle Transmission Shift Cover Assembly.** Apply SAE 10 engine oil to shifting mechanism before cover is placed in position. Install a new shift cover gasket and the shift cover, making sure that fork enters groove in sliding gear. Install the six cap screws with lock washers, and tighten securely.

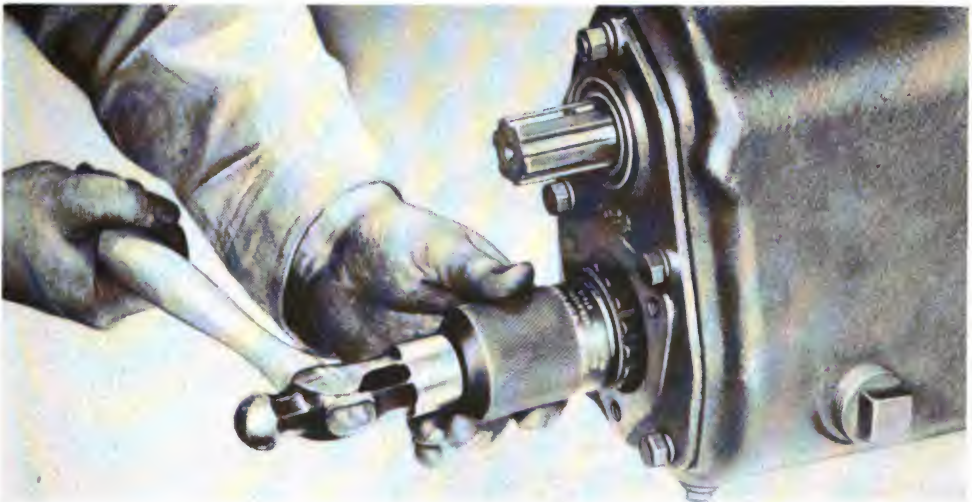


**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**



RA PD 49464

**Figure 95—Installing Axle Transmission Rear Cover Plate**



RA PD 67269

**Figure 96—Installing Pinion Outer Bearing Cone**

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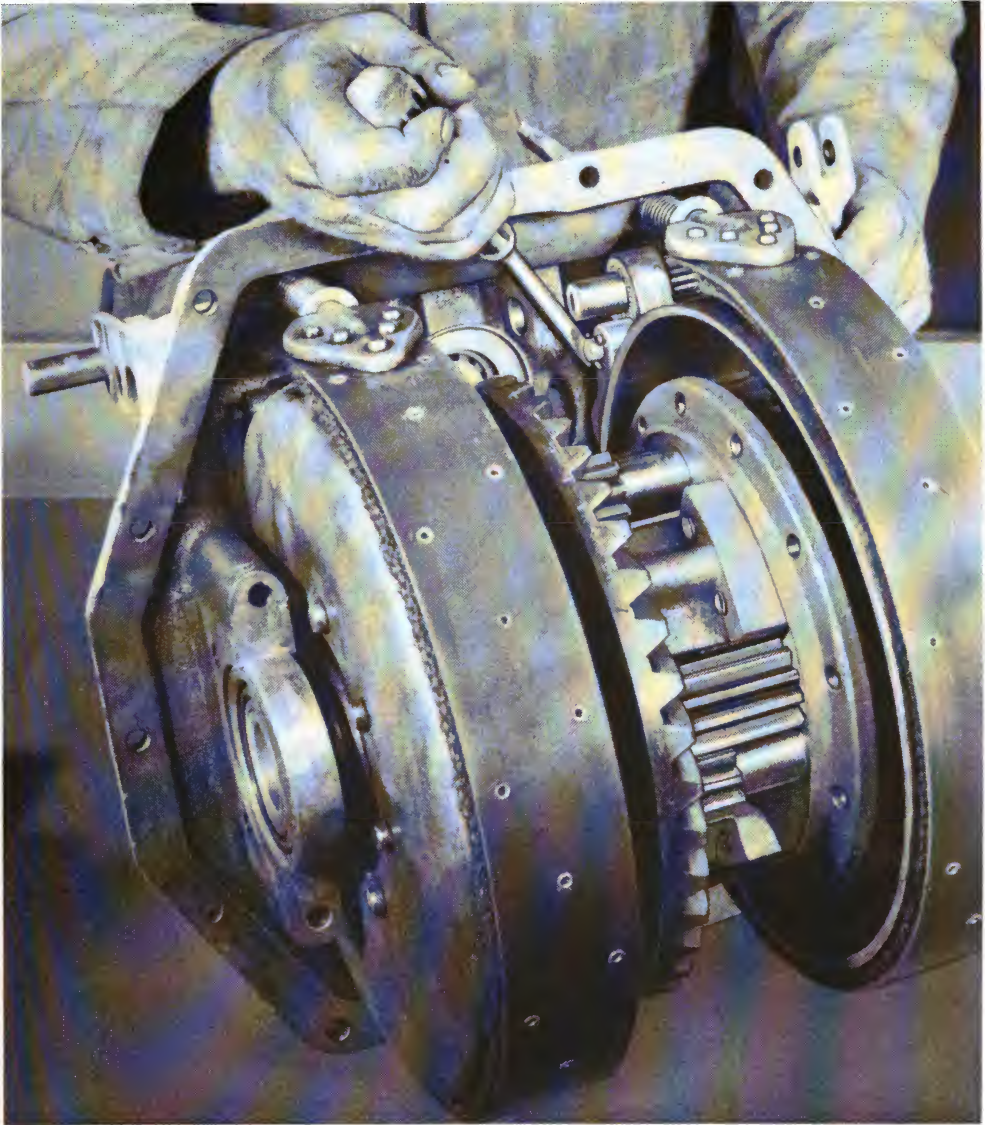
RA PD 49467

**Figure 97—Locking Pinion Outer Bearing Adjusting Nut**



**AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY**

f. **Install Axle Unit Driving Flange.** Install driving flange on splines at rear of mainshaft so that pin hole in flange is alined with hole in mainshaft. Install lock pin and new cotter pin. Test axle transmission to make sure that shafts, bearings, and gears rotate freely, and the shifting mechanism operates properly.



RA PD 49463

**Figure 98—Installing Steering Brake Camshaft**

g. **Install Differential Assembly.** Place differential side bearing cups over cones, and set differential assembly with brake bands into position in case, with bevel drive gear on right side (according to vehicle). Make sure that brake band studs enter holes in upper portion of case. Install right and left side bearing caps on their proper side, and tighten cap screws moderately to hold differential assembly in position. Place new cork seals on camshafts and insert camshafts (with clevises held in a vertical position) through bores of seals, so that splines



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on camshafts mesh with splines in cams (fig. 98). Install adjusting lock plates and adjusting wing nuts on brake band studs. Install differential side bearing retainer plates with shims on their respective sides, and tighten cap screws until snug. Tighten securely the two retainer plate screws that enter case on each side, and then tighten side bearing caps securely. Tighten securely the two retainer plate cap screws on each side that enter side of bearing caps.

**h. Install Steering Levers and Linkage.** Place left steering lever with operating rod and end on steering lever pin. Install tension spring, spacer, link, lock washer, and screw. (The link must be installed so that it will retain the steering lever rod end pin in position.) Tighten the cap screw securely. Install the clevis pin through clevis on camshaft and steering lever adjusting rod eye, using a new cotter pin. Repeat the procedure to install right steering lever and linkage.

**i. Install Axle Housing.** Place a new housing gasket in position on case, using gasket sealer, and install axle housing with cap screws and lock washers. Tighten cap screws securely.

**37. TEST OF ASSEMBLY.**

**a.** Operate axle transmission shift lever to shift the transmission alternately into low and high speed positions. Turn mainshaft driving flange to make sure that internal parts rotate freely without excessive backlash.

**38. STEERING BRAKE BAND ADJUSTMENT.**

**a.** Three points of adjustment are provided for each brake band. Two of these points are to maintain the correct contour of the lining with relation to the drum, and will require adjustment only when the axle unit has been disassembled. These two points consist of adjusting screws with locking nuts; one located in front wall of housing, and the other in bottom of case. The other adjustment, the one to compensate for wear of lining, is located at rear of case, and is controlled by the large wing nut.

**b.** To make an initial adjustment of band, tighten the large wing nut to draw lining into contact with drum; then loosen lock nuts on the clearance adjusting screws. Turn clearance adjusting screws clockwise until the screw contacts the band; then loosen screws, turning counterclockwise two flats, or one-third turn of the screw; this will establish approximately 0.020-inch clearance at these points between end of adjusting screws and band. Hold screw heads stationary, and tighten lock nuts securely. Loosen the large wing nut one or two notches, by turning counterclockwise. (The forward face of each wing nut is notched so that it can be turned only one-half turn at a time, and the adjustment must always be completed so that wing nut notches are engaged with stop ribs on plate just ahead of wing nut.) Remove the cotter and clevis pin from clevis on camshaft and steering lever adjusting rod eye. Shorten or lengthen link by turning adjusting rod as re-

## AXLE DIFFERENTIAL AND TRANSMISSION ASSEMBLY

quired to produce approximately  $2\frac{1}{2}$  inches of free movement (at the upper end of the lever) before the effective stroke begins.

c. Install clevis pin and new cotter pin. Repeat adjustment procedure on other band and lever. Make sure that both levers have essentially the same braking effect, and that linings are not dragging on drums with levers released. Place a few drops of engine oil on lever pivot and clevis pins. Subsequent adjustments to compensate for lining wear will be made with the large wing nuts.

### 39. INSTALLATION AND TEST.

a. **Place Axle Unit in Vehicle.** Attach suitable sling or lifting chain to axle unit, and raise it with a hoist. Lower the unit carefully into place. Aline bolt holes in flanges on each side with holes in hull, using a drift for this purpose. Slide shims into place and insert two guide pins on each side through opposite holes to hold the axle unit in position. Install 6 quarts of SAE 10 engine oil in axle unit and check level at filler plug opening.

b. **Install Final Drives.** Refer to paragraph 28.

c. **Connect Axle Unit.** Fasten both front bomb case wiring tubes in their proper position, and connect the axle unit ventilator pipe. Install the protection pad over top of axle unit housing. Place transmission remote control shift rods in position, connect, and adjust if necessary. Install the shift rods guide and connect speedometer cable nut to speedometer pinion sleeve.

d. **Install Tracks.** Refer to paragraph 47.

e. **Install Propeller Shaft.** Refer to paragraph 19.

f. **Install Seats.** Refer to paragraph 67.

g. **Install Top and Bows.** Refer to paragraph 66.

h. **Test.** Start the engine and drive the vehicle to check the operation of the axle unit.

### 40. FITS AND TOLERANCES.

#### Minimum Backlash

Mainshaft to pinion shaft high speed gears.....	0.005 in.
Mainshaft to pinion shaft low speed gears.....	0.005 in.
Pinion to bevel drive (ring) gear.....	0.006 in.
Between planet gears.....	0.008 in.
Planet pinions to axle shaft drive gears.....	0.010 in.
Planet gears to steering brake drum gears.....	0.012 in.
Mainshaft end play.....	Use shims behind rear bearing cup to produce no end play, but without binding bearings.
Pinion end play.....	Tighten nut at rear bearing to produce no end play, but without binding bearings.

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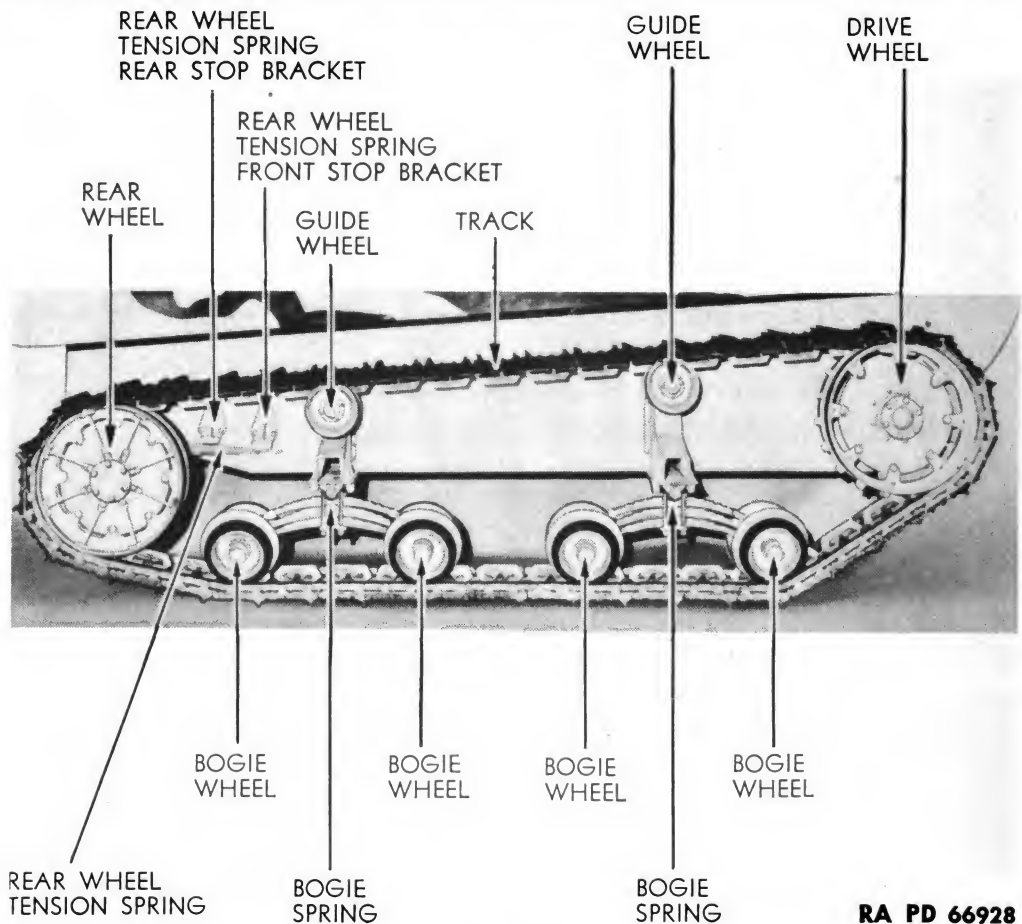
CHAPTER 4

SUSPENSION SYSTEM

Section I

DESCRIPTION, DATA, AND TROUBLE SHOOTING

	Paragraph
Description and operation.....	41
Data .....	42
Trouble shooting .....	43



RA PD 66928

Figure 99—Track and Suspension System

41. DESCRIPTION AND OPERATION.

a. The suspension system of the vehicle includes two endless tracks, 16 bogie wheels, four spring assemblies, driving wheels at the front, and idler wheels at the rear. The rear wheels are mounted on a crank arm which, by means of a spring arrangement, provides for track tension.

## DESCRIPTION, DATA, AND TROUBLE SHOOTING

### 42. DATA.

Number of plates per track.....	41
Width of plates.....	18 in.
Pitch of track.....	6 in.
Height of grouser on plate.....	1 in.
Height of detachable grousers.....	2 $\frac{1}{16}$ in.
Weight of complete track assembly (less detachable grousers)...	246 lb
Number of leaves in rear wheel tension spring.....	8
Number of leaves in three-section bogie spring.....	24

### 43. TROUBLE SHOOTING.

#### a. Track Noisy.

Possible Cause	Possible Remedy
Worn track belt bands.	Replace track.
Bent grouser plates.	Straighten or replace plates.
Damaged or missing drive wheel sprocket teeth.	Replace drive wheel.

#### b. Track Slips or Runs Off Wheels.

Ice or foreign body lodged in suspension system.	Remove interference.
Inadequate track tension.	Adjust tension, or replace damaged or broken parts.
Bent or otherwise damaged guide lugs.	Remove, straighten, and replace or install new.

#### c. Rear Wheel and Crank Arm Noise.

Sprung or damaged wheel or crank arm.	Straighten or replace parts.
Excessively worn or missing wheel rubber covering.	Replace wheel.

#### d. Rear Wheel and Crank Arm, Other Abnormal Conditions.

Excessive wheel end play on crank arm.	Adjust bearings.
Wheel bearings rough, seized, or otherwise damaged.	Install new bearings.
Loss of wheel bearing lubricant.	Install new seal or gasket.
Excessive crank arm end play on support tube.	Readjust crank arm.
Worn crank arm bushings.	Replace bushings.
Broken tension spring leaves.	Replace spring.
Damaged stop brackets or pads.	Replace parts as required.
Rusting or leakage at stop bracket mountings.	Replace gaskets.

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)****e. Bogie Wheel Assembly Noise.**

Possible Cause	Possible Remedy
Worn or damaged wheel bearings.	Replace bearings.
Wheel rubber covering worn excessively.	Replace wheel.
Excessive wheel end play.	Adjust bearings.

**f. Bogie Wheel Assembly, Other Abnormal Conditions.**

Spring shackle seized or bolt broken.	Disassemble, free up, or replace parts as needed.
Spring leaf or parts damaged or broken.	Replace spring.
Bogie set out of alinement with track guide lug.	Straighten hull cross member extension bracket, or replace parts as required.
Bogie wheel spring stops broken.	Install new stops.

**g. Guide Wheels Noisy.**

Excessively worn, or missing wheel rubber covering.	Replace wheel.
Loose wheel support bracket.	Tighten bracket, or replace if damaged.

**h. Guide Wheel, Other Abnormal Conditions.**

Wheel bearings worn or damaged.	Replace.
Lubricant leakage.	Replace seal and gaskets as required.
Support bracket shaft sheared, or weld broken.	Replace support bracket assembly.
Wheel out of alinement with track guide lugs.	Straighten or replace support bracket.



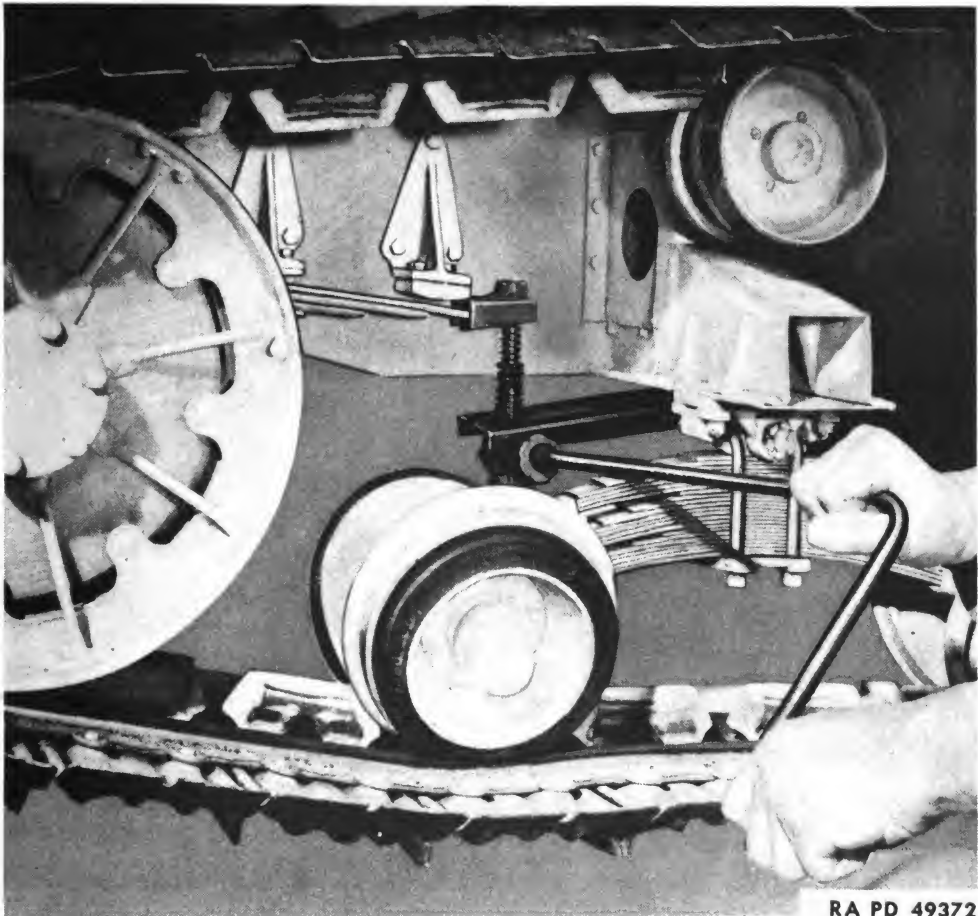
## CHAPTER 4

### SUSPENSION SYSTEM (Cont'd)

#### Section II

#### TRACKS

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Installation .....	47
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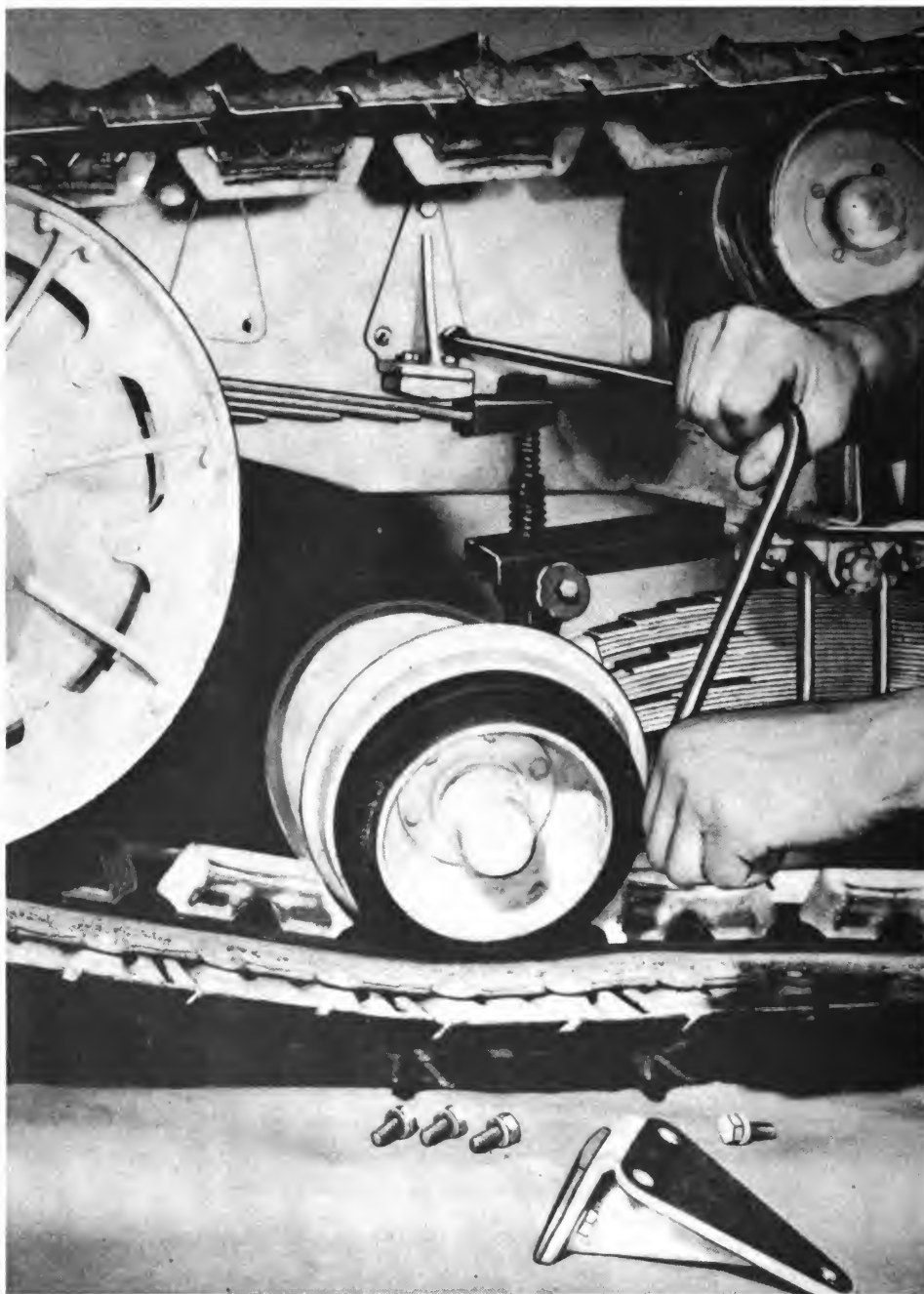
RA PD 49372

**Figure 100—Pulling Track Tension Spring out of Contact  
with Stop Bracket**

#### 44. DESCRIPTION.

a. The endless type track is composed of two fabric rubber belt bands into which are imbedded four continuous steel cables with metal cross plates attached at 3-inch intervals. Ribbed spring steel rubber

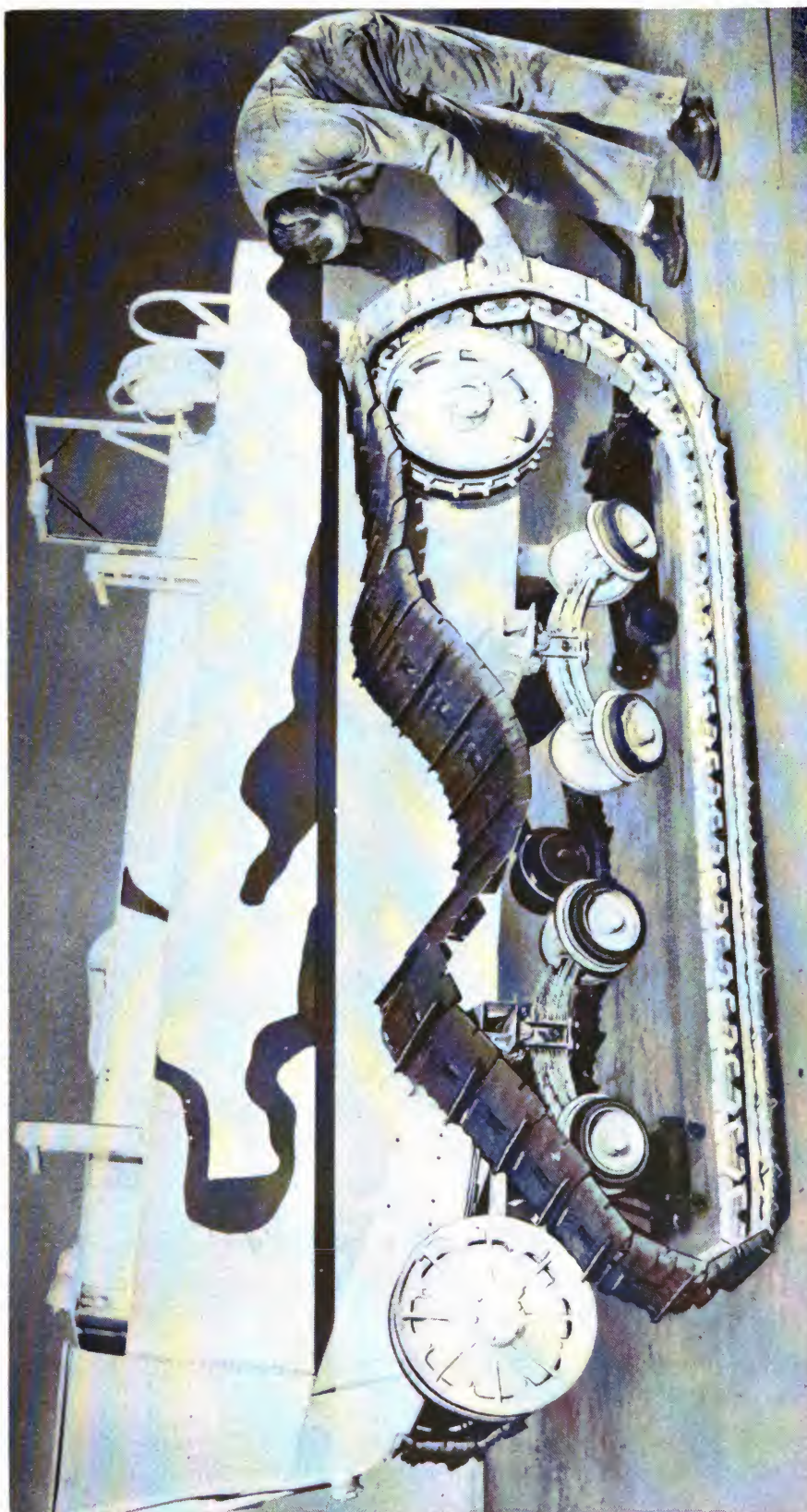
**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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RA PD 49374

**Figure 101—Removing Spring Stop Brackets**

TRACKS



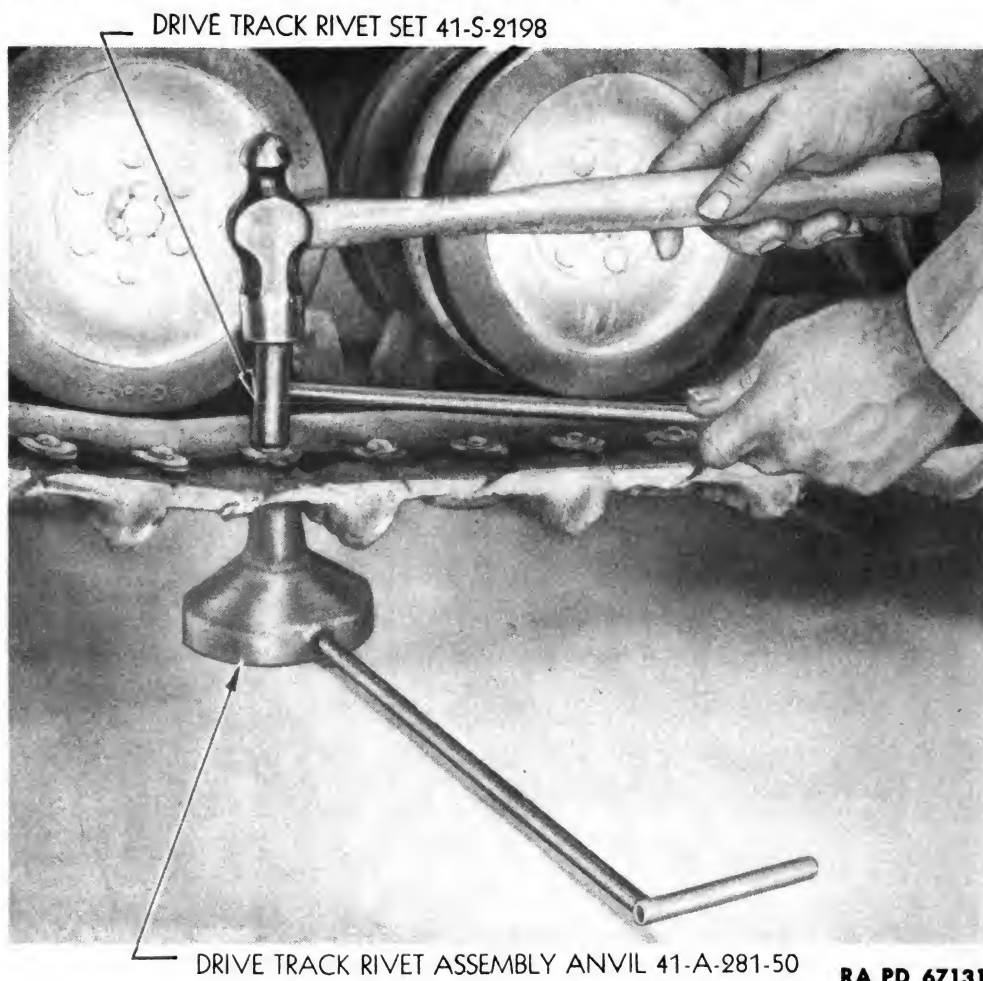
RA PD 49376

**Figure 102 — Removing Vehicle Track**



**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

covered plates and driving lug guide members are riveted to the cross plates. Sprocket teeth on drive wheel enter openings in guides to turn track in either direction. A lug on each guide member directs the track on the supporting wheels. Two grousers (one short and one long) are welded to each plate. The track is designed for vehicle operation in the forward direction, with the short grouser leading at the drive wheel. Insofar as possible, the track is rubber-insulated throughout. Auxiliary grousers are furnished for use in obtaining better traction during operation over fine and deep snow (refer to TM 893—par. 107 b).



RA PD 67131

**Figure 103—Installing Track Rivet**

**45. REMOVAL.**

a. **Raise Vehicle.** Block up the vehicle on side where track is to be removed so track is free to turn.

b. **Remove Rear Wheel Spring Stop Brackets.** Use vehicle jack and bracket attachment to pull front end of rear wheel spring down out of contact with spring hull stop brackets (fig. 100). Remove the three cap screws, holding rearward stop bracket to hull, and remove

## TRACKS

bracket assembly. Remove forward stop bracket in the same manner (fig. 101). Release spring until its front end arcs up under hull. This will allow crank arm holding rear wheel to move forward and relieve track tension.

**c. Remove Track.** Lift track guide lugs out from centers of guide wheels at top. Pull track rearward out of engagement with rear wheel, and bottom of tracks out from under bogie wheels, while track is rotated in forward direction (fig. 102). Remove track from drive wheel. Repeat the procedure to remove other track.

### 46. CLEANING AND INSPECTION.

**a. Cleaning.** Clean tracks thoroughly before inspection by flushing with warm water under pressure. Do not use dry-cleaning solvent, as it is injurious to rubber on tracks.

**b. Inspection.** If only a few track plate rivets are missing, these can be installed satisfactorily without removing track from vehicle. Rivet assembly anvil (41-A-281-50) and rivet set (41-S-2198) are required to perform this operation (fig. 103). Where bent or damaged grouser plates or guide lugs cannot be straightened satisfactorily, the rivets which secure part to track must be cut, and damaged piece removed. New rivets of correct size must be used on installation of track parts.

### 47. INSTALLATION.

**a. Install Track.** Place one track alongside vehicle with short grousers on plates leading (at the front), and long grousers trailing. Lift track at front, place it in position on drive wheel, and lift upper portion of track so that guide lugs are in position in center of guide wheels. Slide as much of bottom of track as possible under the bogie wheels. Move rear wheel crank arm with rear wheel forward as far as possible, pull track rearward, and hook track plates over outer edge of rear wheel. While an assistant at front of vehicle revolves track in forward direction of rotation, push bottom of track toward hull, so it will run into position on rear wheel. Repeat the procedure to install the other track.

**b. Install Rear Wheel Spring Tension Brackets.** Pull front end of one rear wheel spring downward, using rear wheel spring tension release bracket (supplied with vehicle), vehicle jack and handle. Install both stop brackets with new gaskets, installing rear bracket first. Repeat this procedure to install stop brackets on other side.

### 48. ADJUSTMENT.

**a. Method of Checking Track Tension.** Accumulation of snow, ice, or foreign matter must be removed from rear wheel crank arm and spring, as well as from around tension stop brackets and in the immediate area of hull, before any attempt is made to check and adjust



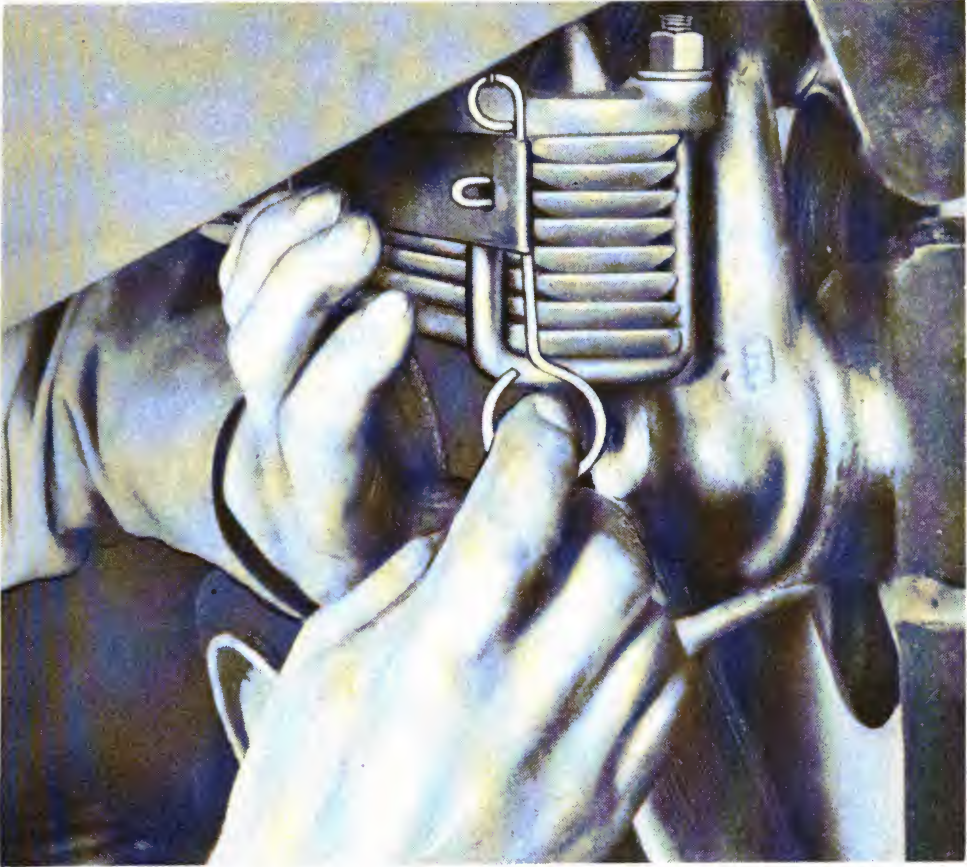
**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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RA PD 49370

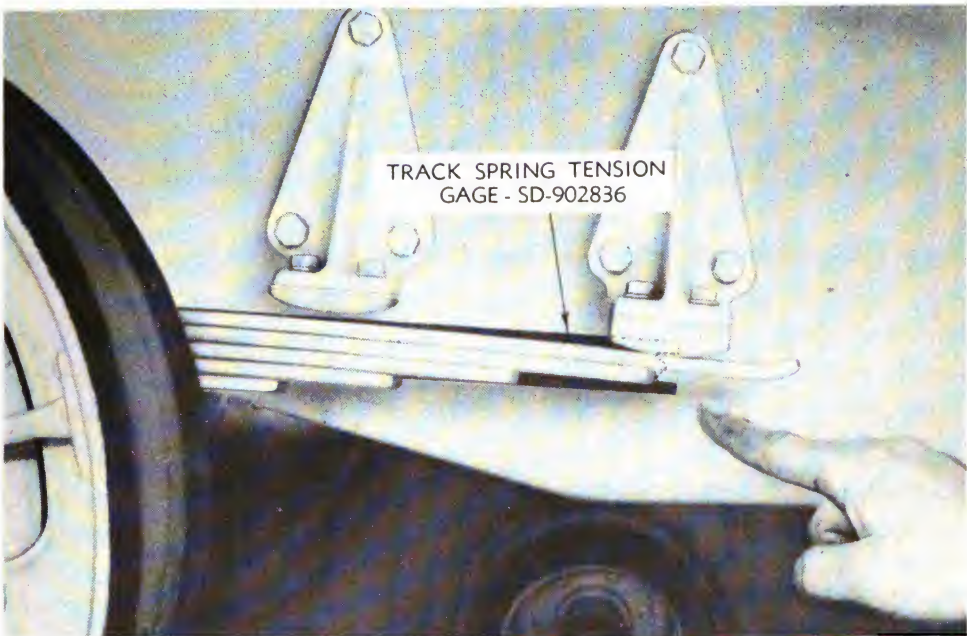
**Figure 104—Positioning Track Tension Gage**

## TRACKS



RA PD 49369

**Figure 105—Hooking Track Tension Gage in Place**



RA PD 58279

**Figure 106—Checking Track Tension**

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM, HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)**

track tension. Make certain that narrow machined edge of rear wheel spring seat, which is exposed between rear end of spring and hull, is clean. With pointer of track spring tension gage (supplied with vehicle) toward front, engage locating ears at the rear of gage between spring U-bolt clips, and flat against machined surface of spring seat (fig. 104). Draw gage hook and spring up and around crank arm and engage hook in hole near rear of gage (fig. 105). Note position of tip of pointer at



RA PD 49373

**Figure 107—Shimming Spring Stop Bracket to Adjust Track Tension**

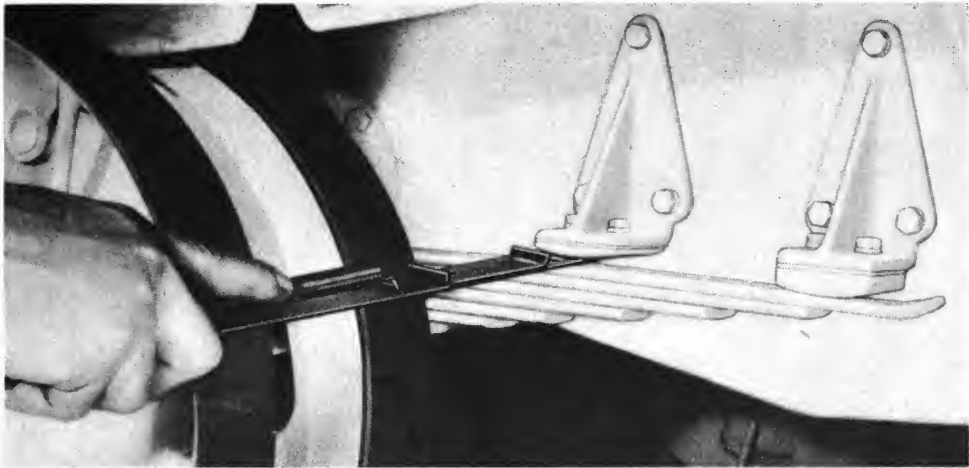
front end of gage with relation to top leaf of spring (fig. 106). If tip of pointer is below top spring leaf, the track is too loose; if tip of pointer is above top leaf of spring, the track is too tight. In either case, the track must be adjusted.

**b. Method of Adjusting Track Tension.** The track tension is reduced by removing shims between convex wear pad at tension spring hub stop (front) bracket and lower face of bracket. The track tension is increased by installing shims at this point. Use vehicle jack and attaching base, with base hooked under hull cross member bogie extension bracket, and jack head over front end of top spring leaf to pull spring down out of contact with spring front stop bracket. Remove

## TRACKS

the two cap screws to free wear pad at base of front bracket. Add, or remove, shims as required to adjust height of tension spring to coincide with tip of gage pointer (fig. 107). Line up shims and wear pads, then install cap screws.

c. **Check and Adjust for Clearance at Rear Stop Bracket.** Use the  $\frac{3}{16}$ -inch thickness gage (part of track spring tension gage) to determine the clearance between rear stop bracket pad and top leaf



RA PD 49371

**Figure 108—Checking Clearance at Rear Stop Bracket**

of spring (fig. 108). If more or less clearance than  $\frac{3}{16}$  inch exists at this point, add or remove shims as in case of front stop bracket. Usually rear stop bracket will require adjustment at the same time as front bracket, to maintain the  $\frac{3}{16}$ -inch clearance. The jack is not used in adjusting at this point.



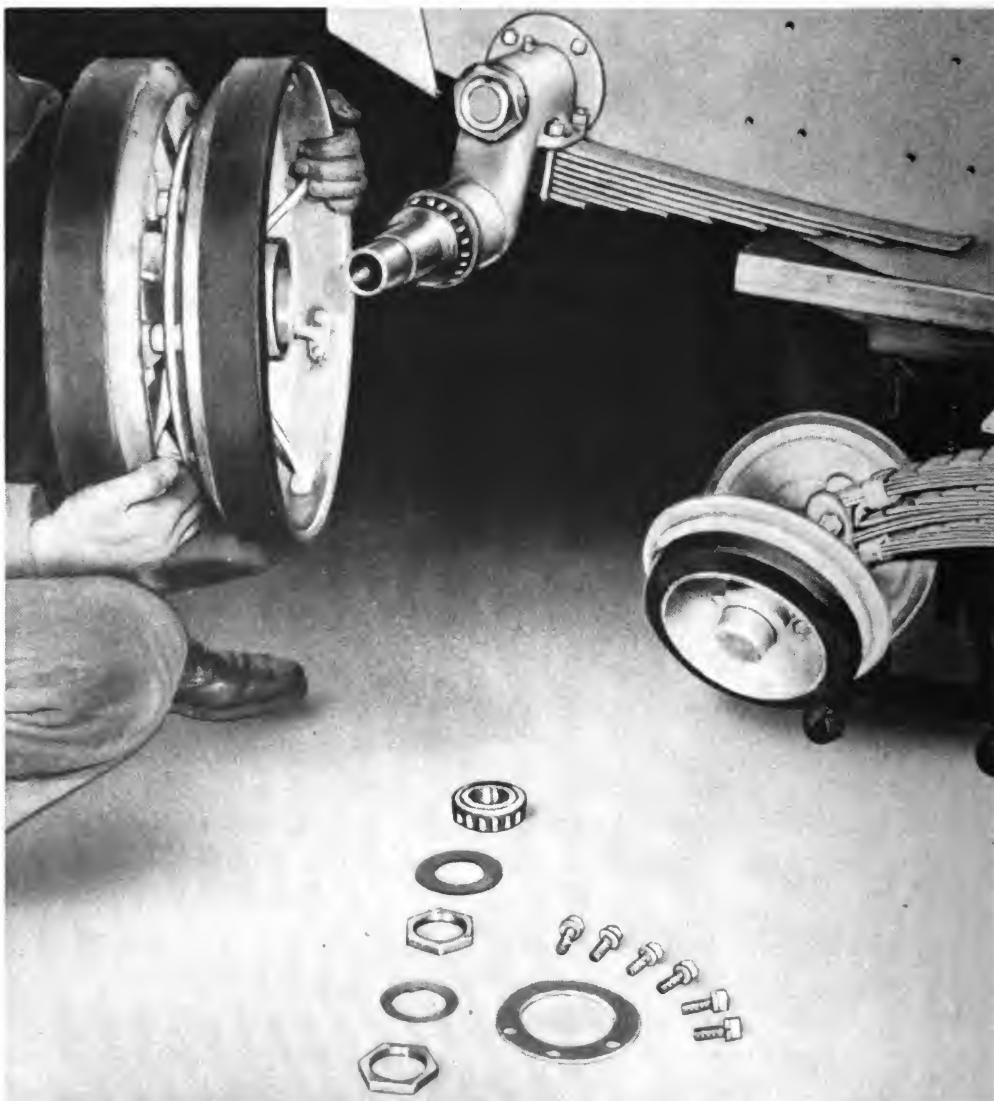
ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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**CHAPTER 4**  
**SUSPENSION SYSTEM (Cont'd)**

**Section III**

**REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY**

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RA PD 49392

**Figure 109—Removing Rear Wheel**

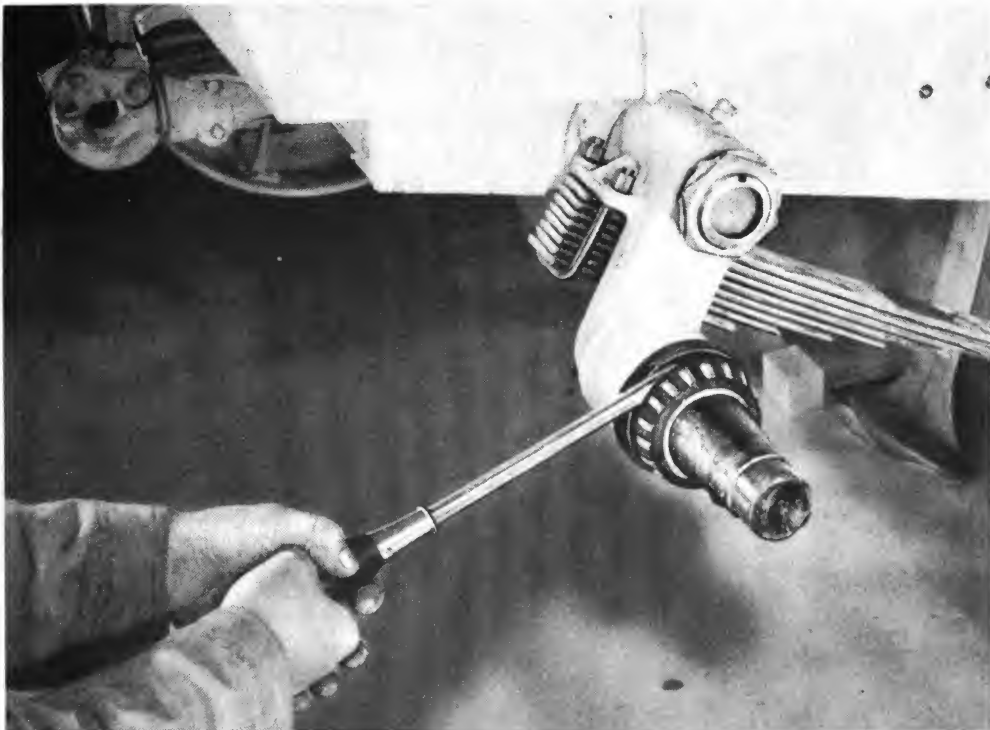


**REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY**



RA PD 49378

**Figure 110—Removing Rear Wheel Crank Arm and Spring**



RA PD 66924

**Figure 111—Removing Rear Wheel Inner Bearing Cone**

ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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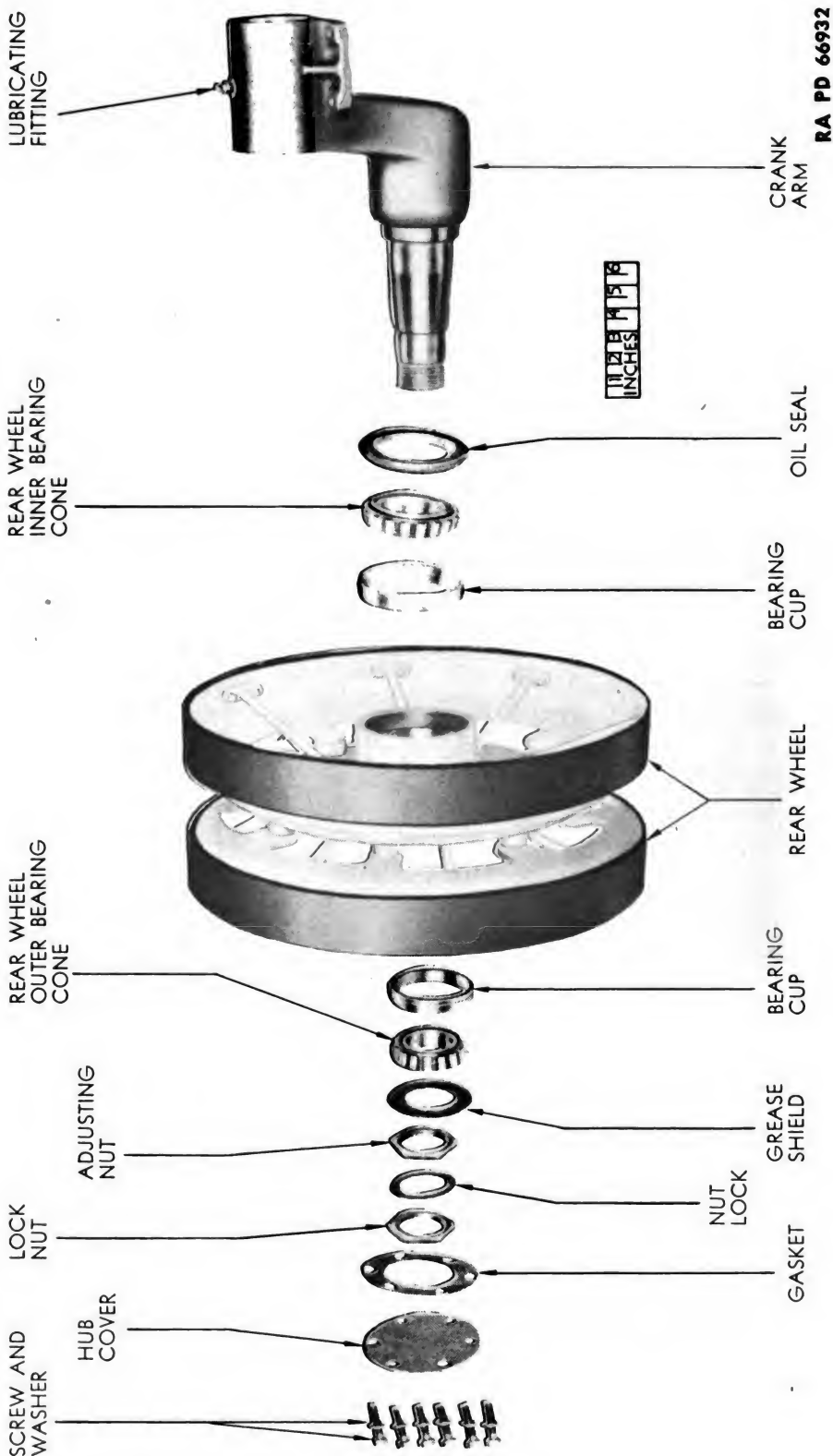
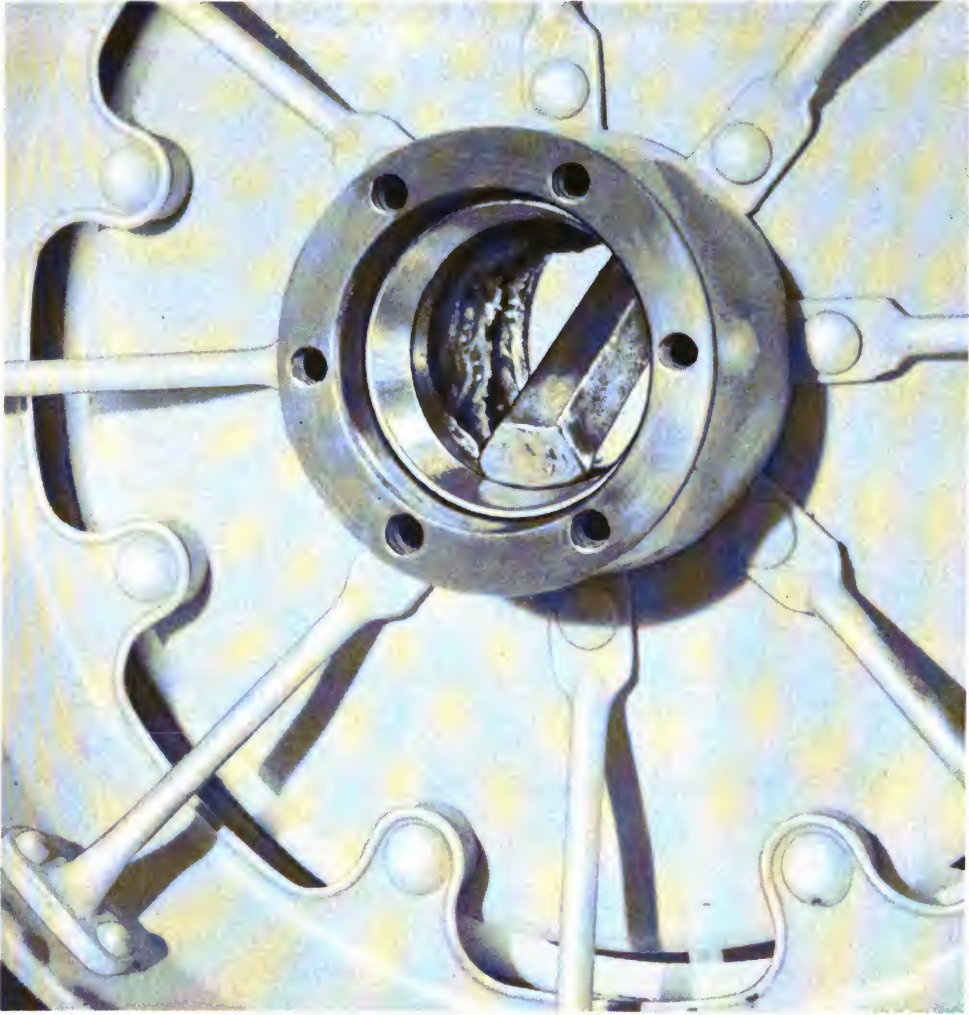


Figure 112—Rear Wheel Parts and Crank Arm

**REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY**



RA PD 66896

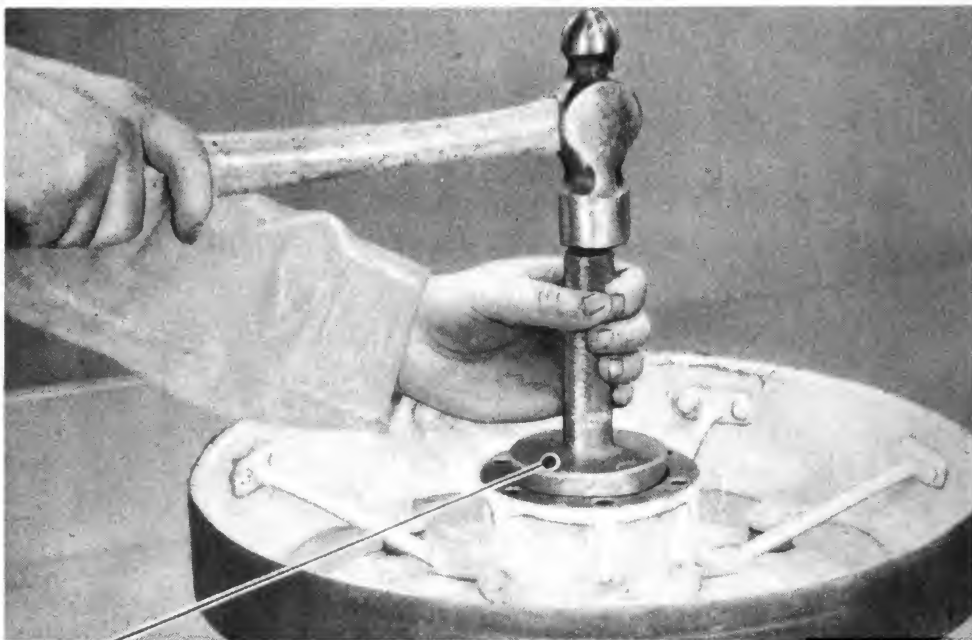
**Figure 113—Removing Rear Wheel Bearing Cups**



RA PD 67261

**Figure 114—Installing Rear Wheel Inner Bearing Cup**

**ORDNANCE MAINTENANCE—POWER TRAIN, SUSPENSION SYSTEM,  
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DRIVE WHEEL INNER AND OUTER BEARING CUP REPLACER 41-R-2394-255

RA PD 67262

***Figure 115—Installing Rear Wheel Outer Bearing Cup***

**49. DESCRIPTION.**

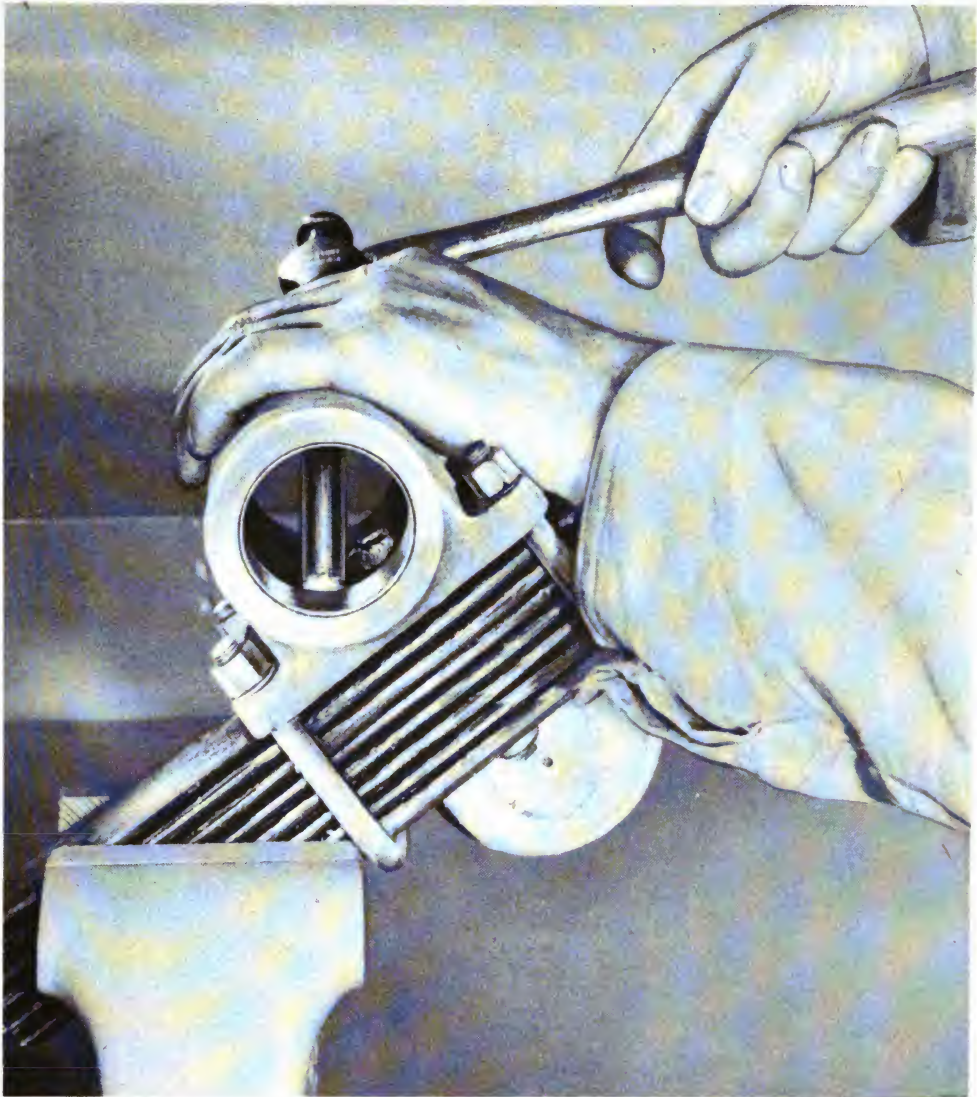
a. This wheel functions to maintain the track spacing and, through its mounting on a crank arm with a cantilever-type spring, track tension adjustment is accomplished. The center section of the wheel is recessed to receive the lugs on the track grouser plates, and a large center disk acts to break up accumulations of snow and ice in the wheels. Recessed in the wheel hub are the bearing cups for the opposed tapered roller bearings, on which the wheel turns free on the spindle portion of the crank arm. A lubricant seal is provided behind the inner bearing cone, and bearing adjustment is maintained by nuts which thread on the outer end of the crank arm spindle. A hub cover seals the wheel bearings from exposure on the outside. The rear wheel crank arm is carried on a support tube, and turns on two bushings recessed in the arm pivot bore. Lubrication at this point is through a fitting located at the top of the crank arm. Adjustment of the arm on the support tube is by hex nuts, which thread on the end of the tube. The tension spring is secured to the crank arm by two U-bolt clips.

**50. REMOVAL.**

- a. **Remove Track.** Perform the operations outlined in paragraph 45.
- b. **Remove Rear Wheel.** Remove the six screws holding hub cover to wheel hub and lift off cover with gasket. Unlock and remove bearing lock nut, lock, and bearing adjusting nut. Lift wheel with outer bearing cone and bearing cups off crank arm spindle (fig. 109).



**REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY**



RA PD 66909

**Figure 116—Removing Carrier Arm Bushings**

c. **Remove Crank Arm Carrier Assembly.** Unlock adjusting nut lock, and remove the lock nut and adjusting nut. Slide carrier with spring off support tube (fig. 110). Remove wheel inner bearing cone from crank arm spindle, after prying it loose with a screwdriver (fig. 111). Remove oil seal, if it is damaged or deteriorated.

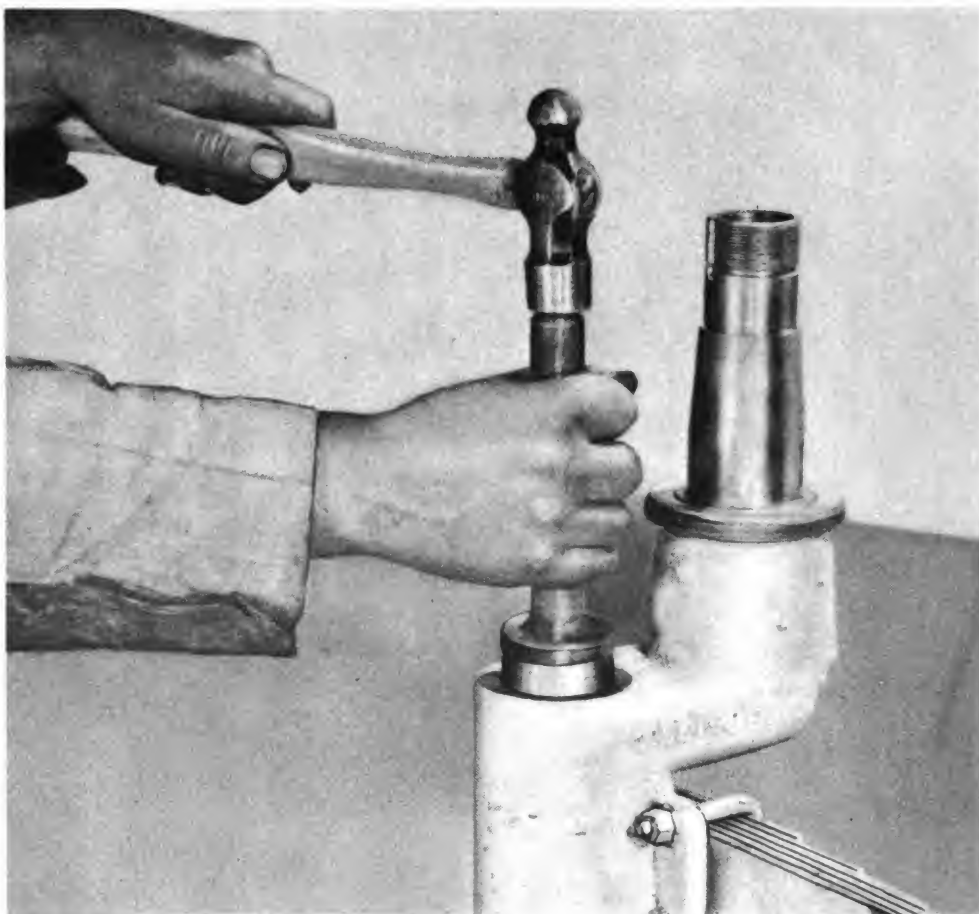
**51. CLEANING, INSPECTION, AND REPAIR.**

a. **Cleaning.** Clean all parts carefully with dry-cleaning solvent, allowing bearing cones to remain in solvent to soak thoroughly. Dry other parts with wiping cloths or compressed air. Remove bearing cones from dry-cleaning solvent and strike them sharply on a wood block



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to dislodge any particles of hardened lubricant. Immerse cones in dry-cleaning solvent; wash them again to remove all lubricant and dirt. Blow cones dry with compressed air, being careful to direct air against side or face of cone, to avoid spinning.



RA PD 67125

**Figure 117—Installing Carrier Arm Bushings**

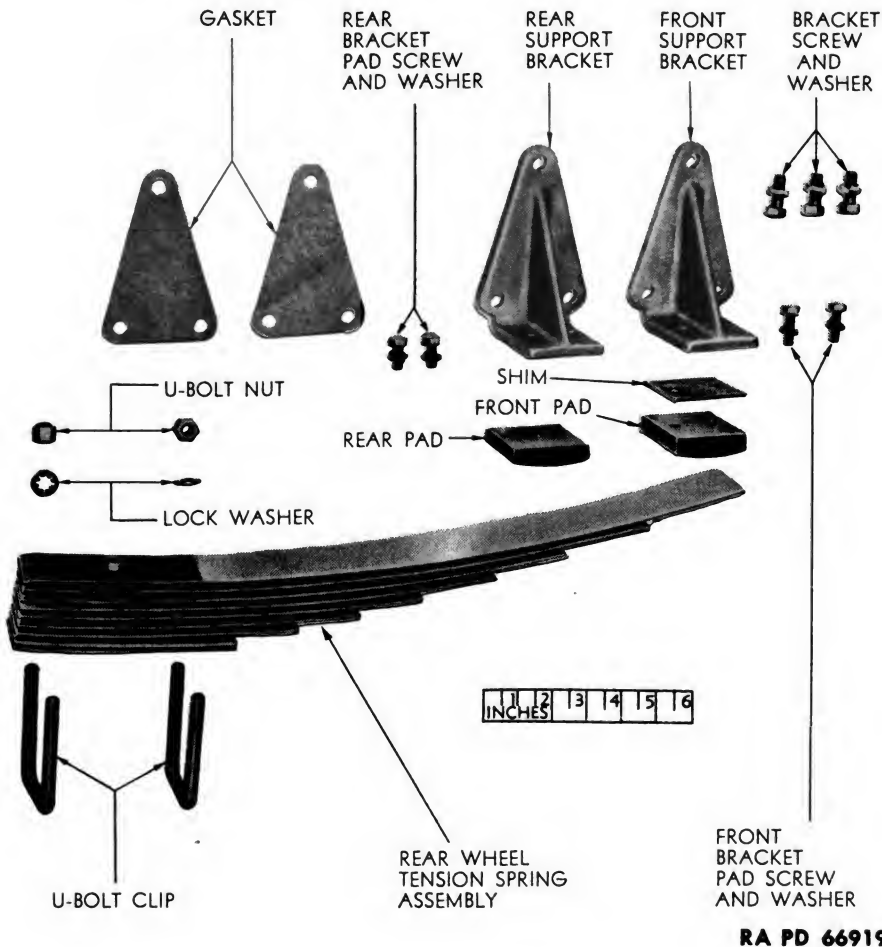
**b. Inspection and Repair.**

(1) **REAR WHEEL.** If necessary, inner and outer wheel bearing cups can be removed from wheel hub by driving against their inner edge with a brass drift, or soft metal bar (fig. 113). If scoring is revealed on bearing cups, or if cones are scored or damaged, replace cups and cones. Install the new parts required, being careful to avoid damaging bearing parts or seal when tapping them into place. Install wheel inner bearing cup (fig. 114) and the outer bearing cup (fig. 115), using inner and outer bearing cup replacer (41-R-2394-255).

(2) **CRANK ARM CARRIER.** To remove tension spring from crank arm, first remove four nuts and locks from two U-bolt clips which hold

## REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY

spring to the under side of arm carrier. If, after cleaning, crank arm bushings are found to be scored or damaged, and require replacement, drive them out of carrier bore (fig. 116). Clean lubricant fitting, using a fine wire. Drive new crank arm bushings into place (fig. 117). When assembling spring, carrier, make sure tension spring center bolt fits into recess of spring seat on crank arm. The U-bolt clip nuts must be



RA PD 66919

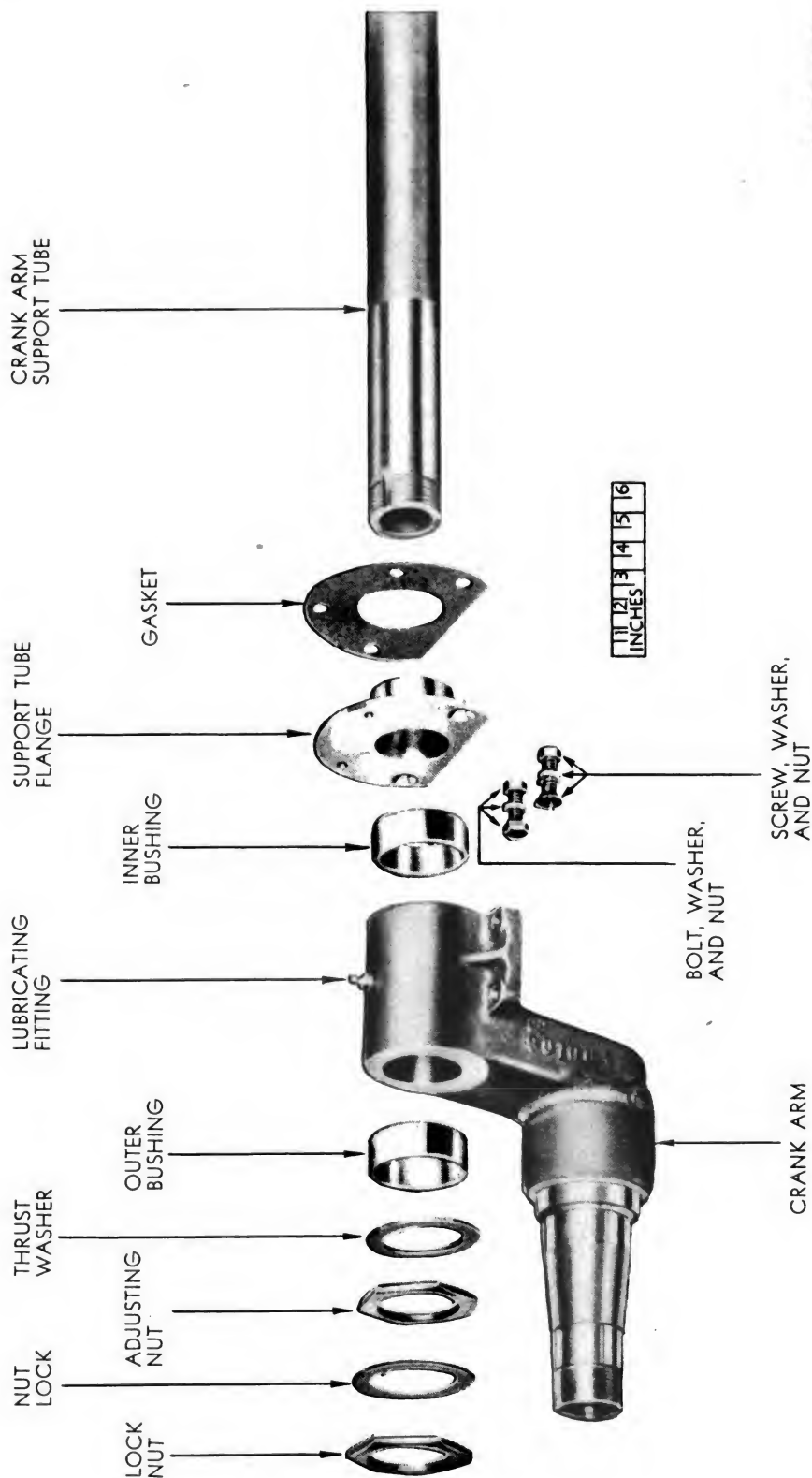
**Figure 118—Parts of the Rear Wheel Spring and Support Brackets**

tightened securely. No special instructions are required for repair operations involving tension spring stop brackets secured to hull.

## 52. INSTALLATION.

a. **Install Crank Arm Carrier Assembly.** Make sure crank arm support tube has been cleaned and that all burrs have been removed. Coat bronze bushings in carrier with No. 0 grease. Install crank arm carrier assembly onto support tube. Install thrust washer and crank arm adjusting nut. Tighten nut until arm and spring move with difficulty, then back off nut one-sixth turn. Install lock and lock nut, and bend a portion of the lock over a flat on each nut.

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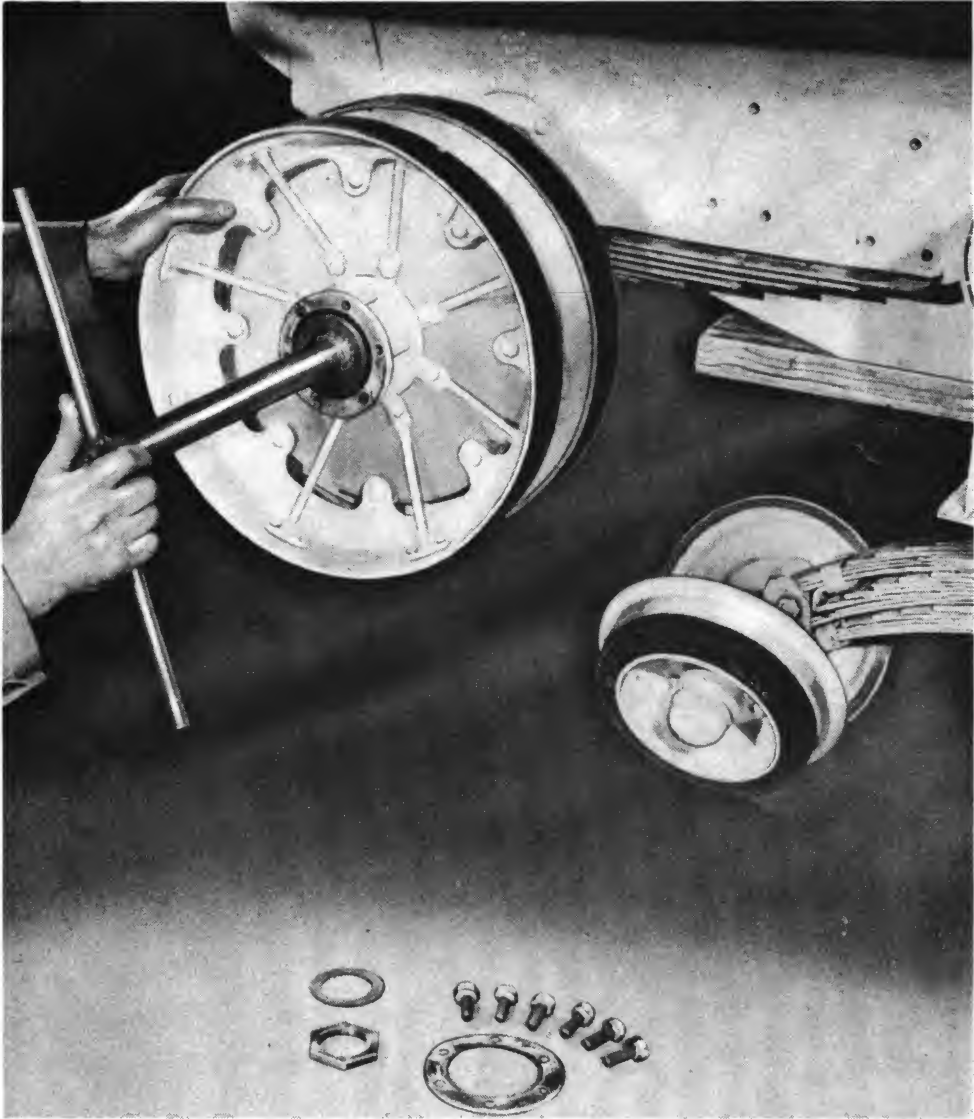


RA PD 66931

Figure 119—Rear Wheel Crank Arm and Support Tube Parts

**REAR WHEEL AND CRANK ARM CARRIER ASSEMBLY**

b. **Install Rear Wheel.** Hand pack bearings with No. 0 grease and install inner bearing cone on crank arm spindle. Install rear wheel and outer bearing cone on crank arm, and adjust bearings by installing the adjusting nut, and tightening with  $2\frac{7}{16}$ -inch single head socket wrench (41-W-2940-55) until the wheel turns with difficulty (fig. 120). Back



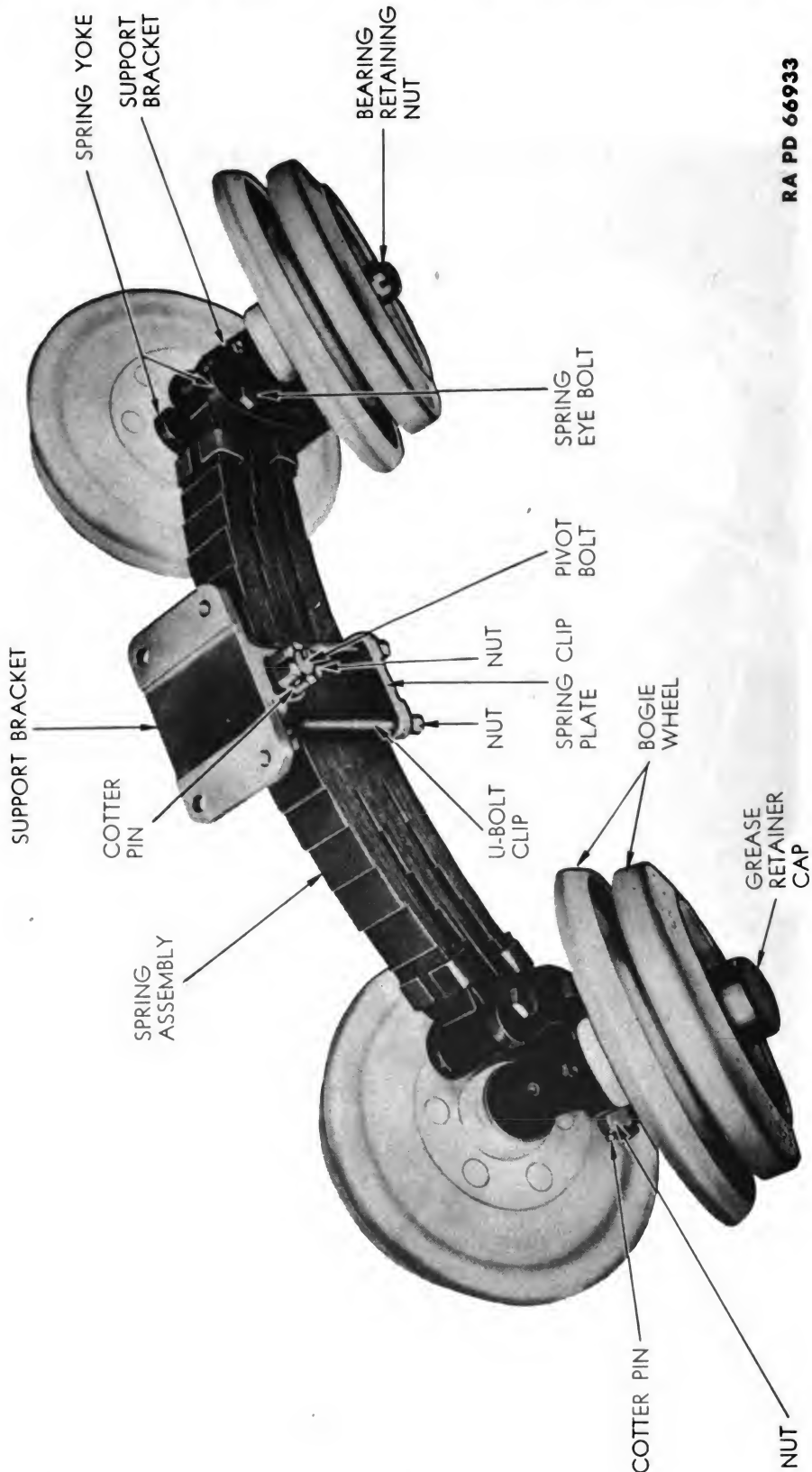
RA PD 49393

**Figure 120—Adjusting Rear and Drive Wheel Bearing**

off adjusting nut one-sixth turn to give proper final adjustment. Install nut lock and lock nut; bend lock over nuts at opposite points. Install a new gasket and the hub cover.

c. **Track Installation and Tension Adjustment.** Install vehicle track as directed in paragraph 47, and adjust track tension in accordance with instructions given in paragraph 48.

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RA PD 66933

Figure 121—Bogie Assembly



## CHAPTER 4

### SUSPENSION SYSTEM (Cont'd)

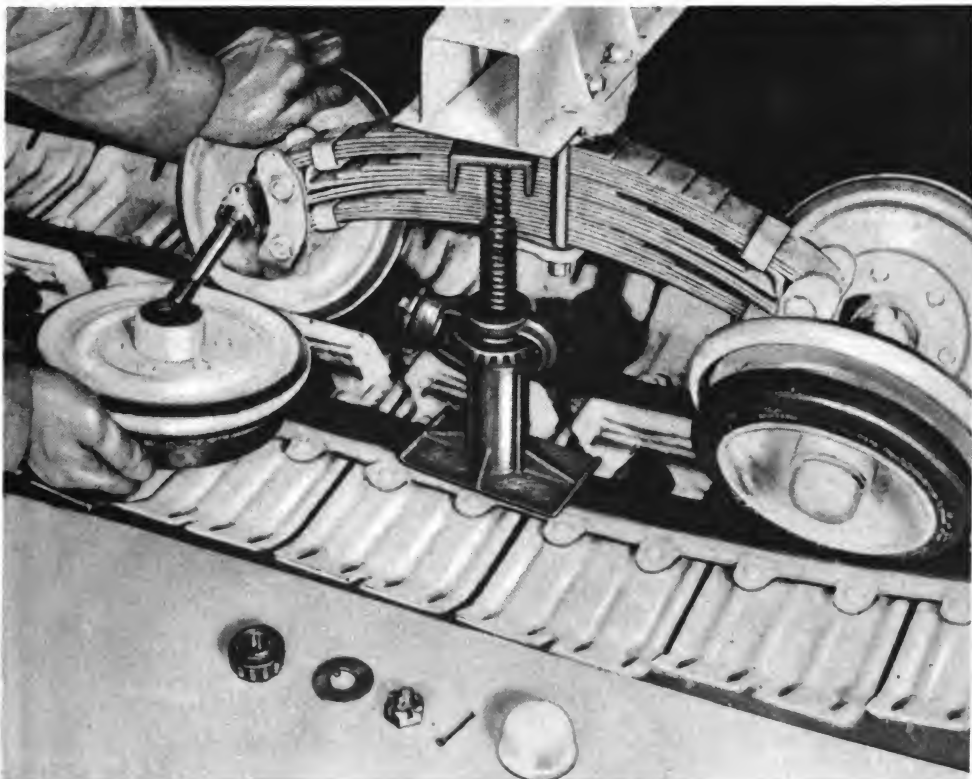
#### Section IV

### BOGIE WHEEL ASSEMBLY

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#### 53. DESCRIPTION.

a. Two bogie sets on each side support the weight of the vehicle through brackets which extend from the side of the hull. Each set is



RA PD 49366

**Figure 122—Removing Bogie Wheel**

comprised of a 3-section semi-elliptical spring, four bogie wheels operating in pairs, and connecting parts. That portion of the bogie wheel which rides the track belt band is rubber-tired. Each pair of wheels

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RA PD 67256

**Figure 123—Removing Bogie Wheel Hub Cap**

RA PD 67260

**Figure 124—Removing Bogie Wheel Hub Bearing Cups**

turns on the spindles of a bogie support bracket through tapered roller bearings. Adjustment of the bearing is made at a nut threaded to the bracket spindle directly behind the wheel hub cap. A fixed stop, which is an integral part of the mounting bracket, limits the axial turning of

## BOGIE WHEEL ASSEMBLY

the bracket on the spring yoke pin to which it is mounted. The yoke is shackled to the upper and lower bogie spring and eyes. Two U-bolt clips and a plate secure the spring to a bracket, which turns on a pivot bolt in a support bracket bolted to the hull cross member extension bracket. Spring bumper stops, mounted just below the bogie support bracket, limit the spring flexing, and consequent upward and downward movement of the wheels. A rerailer is furnished to facilitate directing bogie wheels back onto track belt bands in the event the wheels are forced off during operation (refer to TM 9-893).

### 54. REMOVAL.

**a. Remove Bogie Assembly.** Block up under vehicle where bogie assembly is to be removed. Take out the four cotter pins and remove the bolts and nuts with locks which hold bogie assembly to hull cross member support bracket. Remove spring stops and lift bogie assembly out of contact with track, and away from vehicle.

**b. Removal of Bogie Wheel Only.** If only a bogie wheel is to be removed, this operation can be performed with bogie assembly and track in place on vehicle. Relieve the vehicle's weight from bogie assembly by jacking between hull cross member support bracket, and outer track belt band, until wheel flange will clear track band. Pry loose, and remove the wheel hub cap. Take out the cotter pin and remove wheel bearing adjusting nut. Slip wheel and bearings, with oil seal, off support bracket spindle (fig. 122).

### 55. DISASSEMBLY AND CLEANING.

#### **a. Disassembly.**

(1) **REMOVE SUPPORT BRACKET AND WHEELS ASSEMBLY.** Remove the cotter pin, nut, and washer and slip the support bracket and wheels assembly off the spring yoke pin at each end of the bogie set.

(2) **SPRING YOKE REMOVAL.** Remove the two spring shackle bolt nuts and bolts to free the spring yoke from the spring. Repeat this operation at the other end of the spring.

(3) **SPRING SUPPORT PARTS REMOVAL.** Remove the two spring U-bolt clip nuts and lock washers, and each clip. Remove the lower plate from the U-bolts in order to lift off the upper spring bracket and hull cross member attaching bracket.

(4) **BOGIE WHEEL DISASSEMBLY.** Remove the wheel hub cap (fig. 123), cotter pin, and nut to slide the bogie wheel, with bearings and oil seal, off the support bracket spindle. Use a brass drift on inner bearing cone when driving out oil seal, spacer, and bearing cone. If necessary, drive out inner and outer bearing cups from bogie wheel hub (fig. 124).

(5) **SPRING UPPER SUPPORTING BRACKETS DISASSEMBLY.** Remove cotter pin and nut, and remove pivot bolt, fastening spring bracket to cross member attaching bracket.

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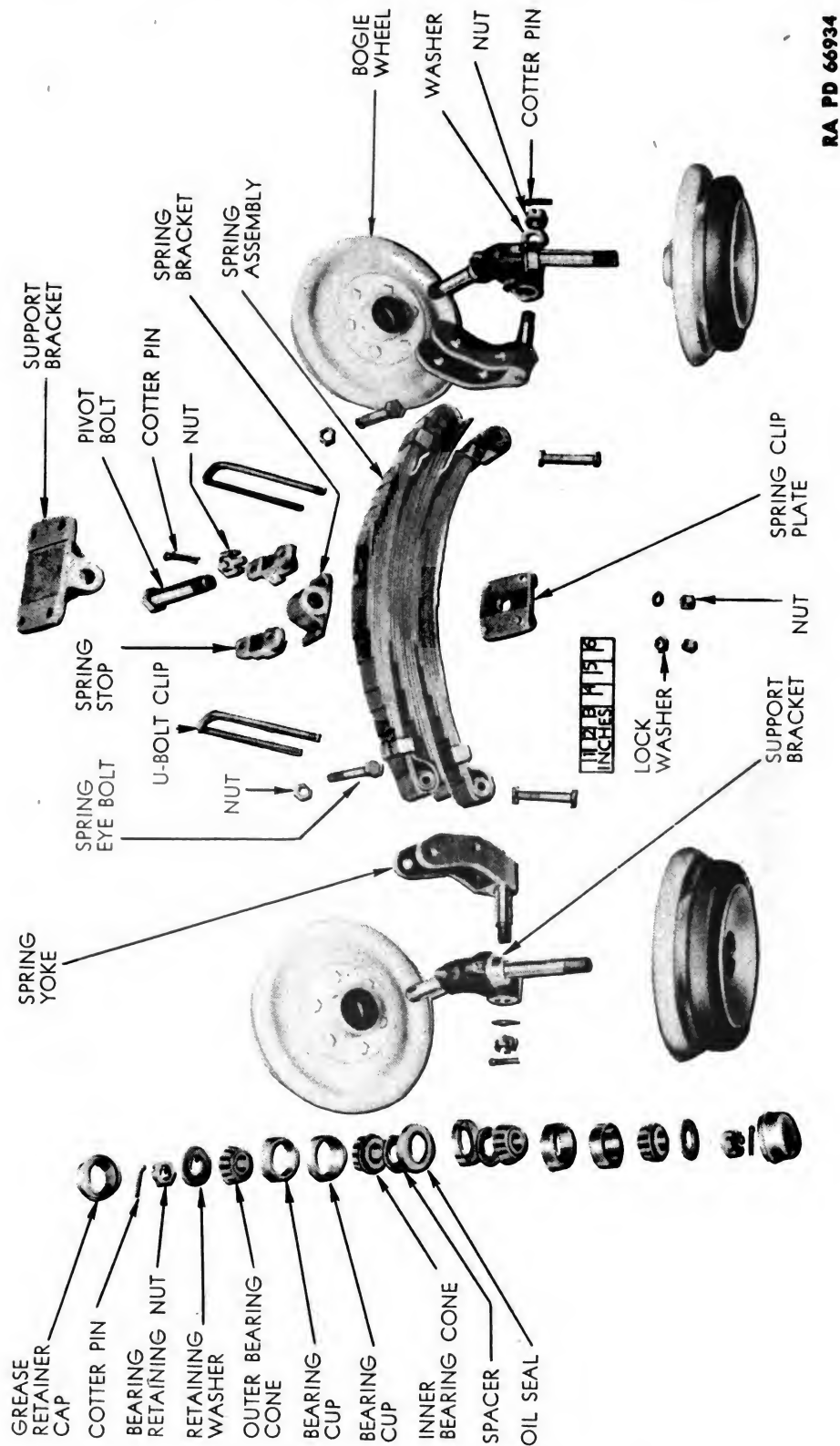
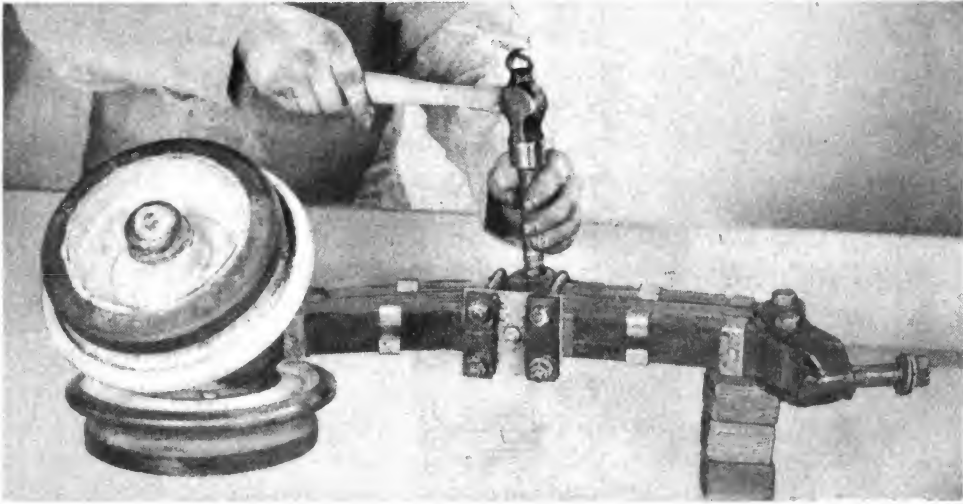


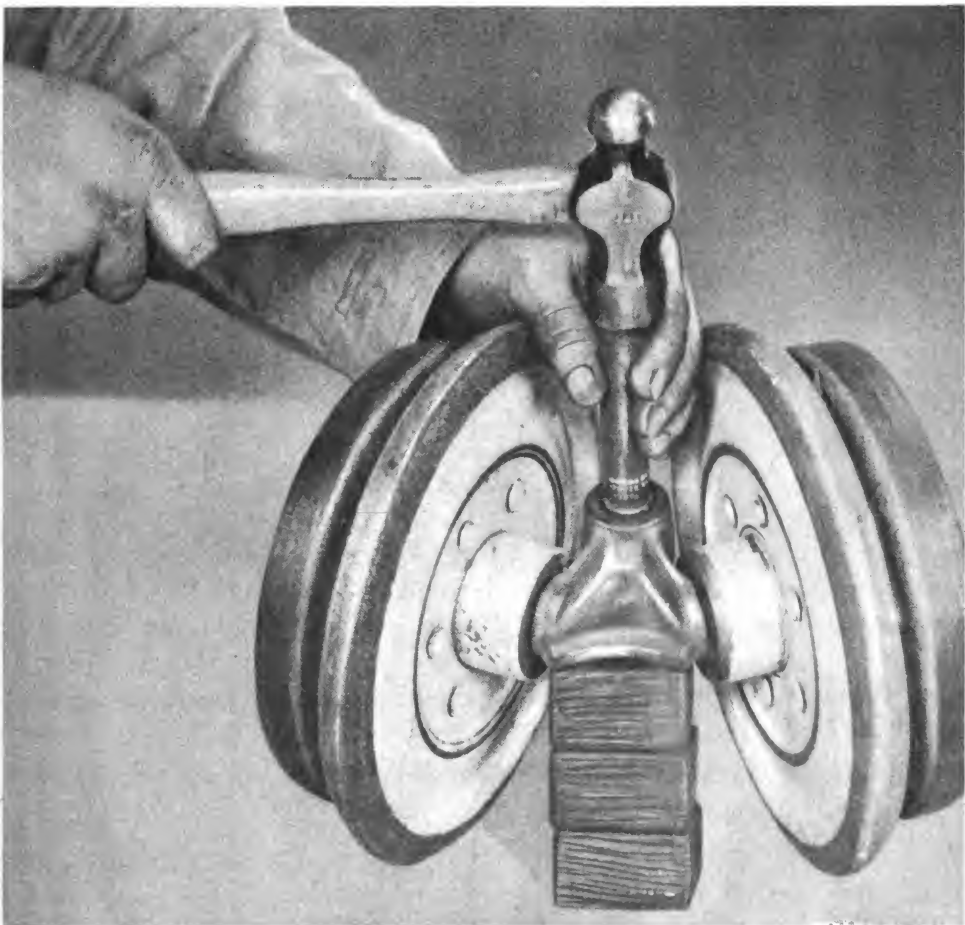
Figure 125—Bogie Wheel and Suspension Parts

## BOGIE WHEEL ASSEMBLY



RA PD 67257

**Figure 126—Replacing Bogie Wheel Spring Bracket Bushings**



RA PD 67258

**Figure 127—Replacing Bogie Wheel Support Bracket Bushing**



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b. **Cleaning.** Clean all parts carefully with dry-cleaning solvent, allowing bearing cones to remain in the dry-cleaning solvent to soak thoroughly. Dry other parts with wiping cloths or compressed air. Remove bearing cones from dry-cleaning solvent and strike them sharply on a wood block to dislodge any particles of hardened lubricant. Immerse cones in dry-cleaning solvent again, and wash them to remove all lubricant and dirt. Blow cones dry with compressed air, being careful to direct air against side or face of cone, to avoid spinning.



RA PD 67259

**Figure 128—Installing Bogie Wheel Hub Bearing Cups**

**56. INSPECTION, REPAIR, AND ASSEMBLY.**

a. **Inspection and Repair.** Examine parts carefully for breakage, or other damage which renders them unfit for further service. If new bushings are needed in bogie wheel spring support bracket, drive out bushings and install new ones (fig. 126). If necessary, replace bogie wheel support bracket bushing (fig. 127). Where bushings are not available, replace the entire part involved; replace bogie wheel bearing cups and cones found to be scored, or otherwise damaged. Smooth down any

## BOGIE WHEEL ASSEMBLY

burs detected on spring yoke pins or pivot bolt. Where new spring yokes or wheel support brackets are required, make sure that correct part is specified as related to bogie assembly location on vehicle, and whether front or rear. Install a new spring when damaged or broken leaves are detected.

### b. Assembly.

(1) **ASSEMBLE AND INSTALL SPRING UPPER BRACKETS.** Coat upper spring bracket bushing with No. 0 grease, and assemble to support attaching bracket with pivot bolt, castle nut, and new cotter pin. Place upper spring bracket, with support attaching bracket attached, in position on spring so that center bolt head enters recess in bracket. Install U-bolt clips and lower plate, and tighten securely with nuts.

(2) **INSTALL SPRING YOKE.** Coat spring shackle bolts with No. 0 grease. Place spring yoke in position over spring eyes, install shackle bolts, and tighten nuts snugly, being careful not to distort the yoke. Repeat the procedure to install the other yoke.

(3) **ASSEMBLE AND INSTALL BOGIE WHEEL PARTS.** Install bogie wheel bearing cups in wheel hub (fig. 128). Pack inner bearing cone with No. 0 grease, and place in wheel hub inner cup. Install new wheel inner bearing oil seal with inner oil seal replacer (41-R-2394-257) (fig. 129). Place bogie wheel, with inner bearing and oil seal, on support



BOGIE WHEEL INNER OIL SEAL  
REPLACER 41-R-2394-257

RA PD 67254

**Figure 129—Installing Bogie Wheel Inner Wheel Bearing Oil Seal**

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bracket spindle. Pack outer bearing cone with No. 0 grease and install cone, retaining washer, and castle nut. Tighten wheel bearing adjusting nut until wheel turns with difficulty, then loosen nut one-sixth turn to free bearings, and install new cotter pin. Install hub cap (fig. 130). Repeat the procedure to install the other wheels.

(4) **INSTALL BOGIE WHEELS AND SUPPORT BRACKET.** Coat spring yoke pin with No. 0 grease, and install support bracket with bogie wheels on yoke pin so that stop on support bracket is toward yoke. Install castle nut on yoke pin, and tighten until support bracket is against stop on yoke pin. Install a new cotter pin. Repeat the procedure to install the other bogie wheels and support bracket.



RA PD 67255

**Figure 130—Installing Bogie Wheel Hub Cap**

**57. INSTALLATION.**

a. Note that spring stop bumpers, which bolt on just below bogie support attaching bracket, must be installed with edge having greater thickness toward middle of spring. When installing a front bogie set make sure the spring yoke, which allows a higher mounting of the spring end, is at front of vehicle. On rear bogie set, the stop on wheel support bracket, permitting greater tilt of wheels, goes toward front of vehicle. Where only a bogie wheel was removed, leaving the remainder of bogie set and track in place on vehicle, make sure that bearings are packed with No. 0 grease before installation; then adjust bogie wheel bearings (par. 56). Place the assembly in position, install the four bolts holding assembly to mounting bracket, install lock washers, and tighten nuts securely. Remove blocks and lower vehicle.

## CHAPTER 4

### SUSPENSION SYSTEM (Cont'd)

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#### Section V

### GUIDE WHEEL ASSEMBLY

	Paragraph
Description .....	58
Removal .....	59
Cleaning, inspection, and repair .....	60
Installation .....	61

#### 58. DESCRIPTION.

a. Above each bogie set is a single guide wheel which functions to support and guide the track throughout its top travel. The portions of the wheel on which the track belt bands ride, are rubber-covered. The wheel turns on two needle bearings located in its hub, and is supported on a spindle, which is a part of the guide wheel bracket fastened to the hull and cross member support bracket extension. The desired amount of wheel end play on the spindle or shaft is provided for in design. A cap screw threads into the end of the shaft, and with a washer, retains the wheel on the shaft. A combination lubricant seal and cap is used at the inner side of the wheel hub, and a cap on the outer side of the hub seals the internal parts against exposure to the elements.

#### 59. REMOVAL.

a. **Relieve Track Tension.** Relieve tension on track as directed in paragraph 45. Lift track so that inner guide lugs clear center portion of guide wheel.

b. **Wheel Removal.** Take out the four hub cap screws with lock washers, and remove hub cap and gasket. Remove wheel retaining screw, lock, flat, and thrust washers. Remove guide wheel with needle bearings and oil seal.

#### 60. CLEANING, INSPECTION, AND REPAIR.

a. **Cleaning.** Clean guide wheel hub and bearings thoroughly with dry-cleaning solvent, using a small, stiff-bristled brush, and blow dry with compressed air. Apply dry-cleaning solvent to guide wheel support bracket shaft with a brush or cloth, to remove all grease and dirt.

b. **Inspection and Repair.** Removal of inner oil seal cap and gasket is the same as performed at hub cap. If damaged, remove the two roller-type bearings in wheel hub with a brass punch (fig. 133). Install new bearings using needle bearing replacer (41-R-2391-29) to

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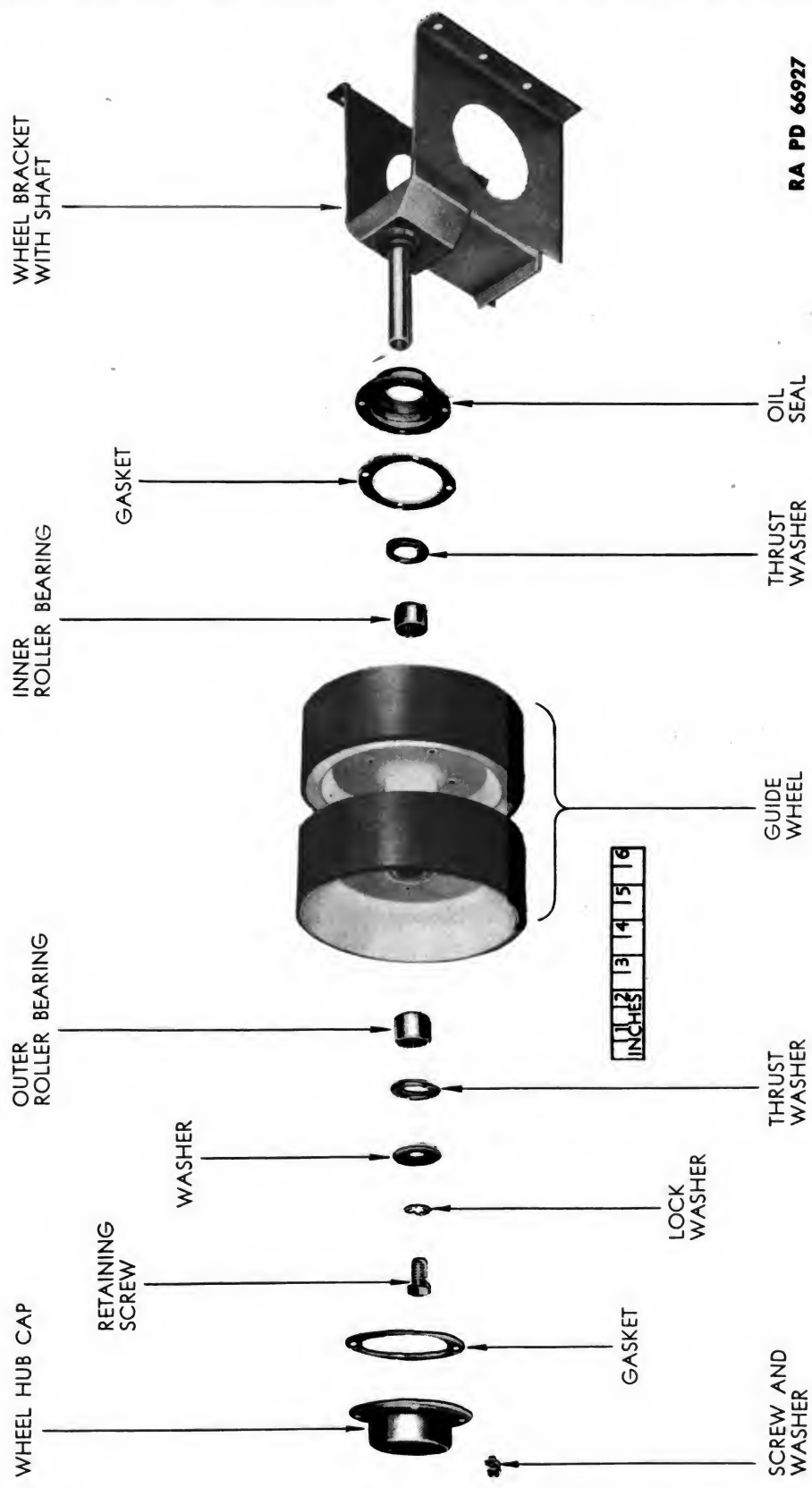
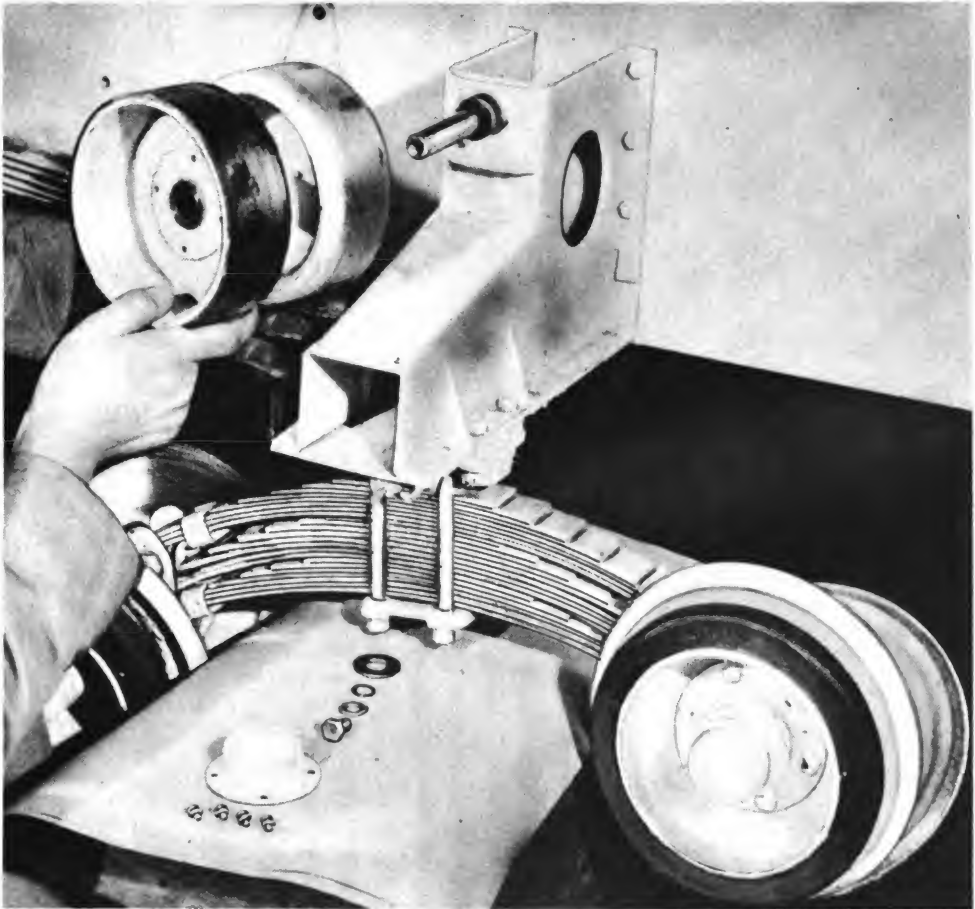


Figure 131—Guide Wheel, Wheel Bearings, and Bracket



## GUIDE WHEEL ASSEMBLY

force bearings into position in guide wheel hub (fig. 134). Smooth off any burs found on shaft. If a close inspection reveals wheel support bracket and shaft are damaged, and unfit for further service, replace support bracket and shaft. If rubber covering on wheel is torn or damaged, replace wheel. Install a new inner cap oil seal assembly and gasket.



RA PD 49367

**Figure 132—Removing Guide Wheel**

### 61. INSTALLATION.

a. After packing wheel bearings with No. 0 grease, install wheel by placing it on spindle, installing thrust, flat, and lock washers, and wheel retaining screw. Proper end play is provided for in design of wheel and support bracket shaft; therefore, tighten wheel retaining screw securely. Use a new gasket when installing hub cap. Adjust track tension, (par. 48).

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RA PD 66916

**Figure 133—Removing Guide Wheel Bearings**



NEEDLE BEARING REPLACER 41-R-2391-29

RA PD 67190

**Figure 134—Installing Guide Wheel Bearings**

## CHAPTER 4 SUSPENSION SYSTEM (Cont'd)

### Section VI

### FITS AND TOLERANCES

**Paragraph**

Suspension system service data..... 62

#### 62. SUSPENSION SYSTEM SERVICE DATA.

Bogie and rear wheels bearing adjustment.	Tighten adjusting nut until wheel turns with difficulty, then back off $\frac{1}{6}$ turn.
Crank arm carrier adjustment.	Tighten adjusting nut until carrier turns with difficulty, then back off $\frac{1}{6}$ turn.
Clearance between tension spring and rear stop bracket pad.	$\frac{3}{16}$ in.
Normal track tension.	900 to 1000 lb

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**CHAPTER 5**  
**HULL AND HULL ELECTRICAL SYSTEM**

**Section I**

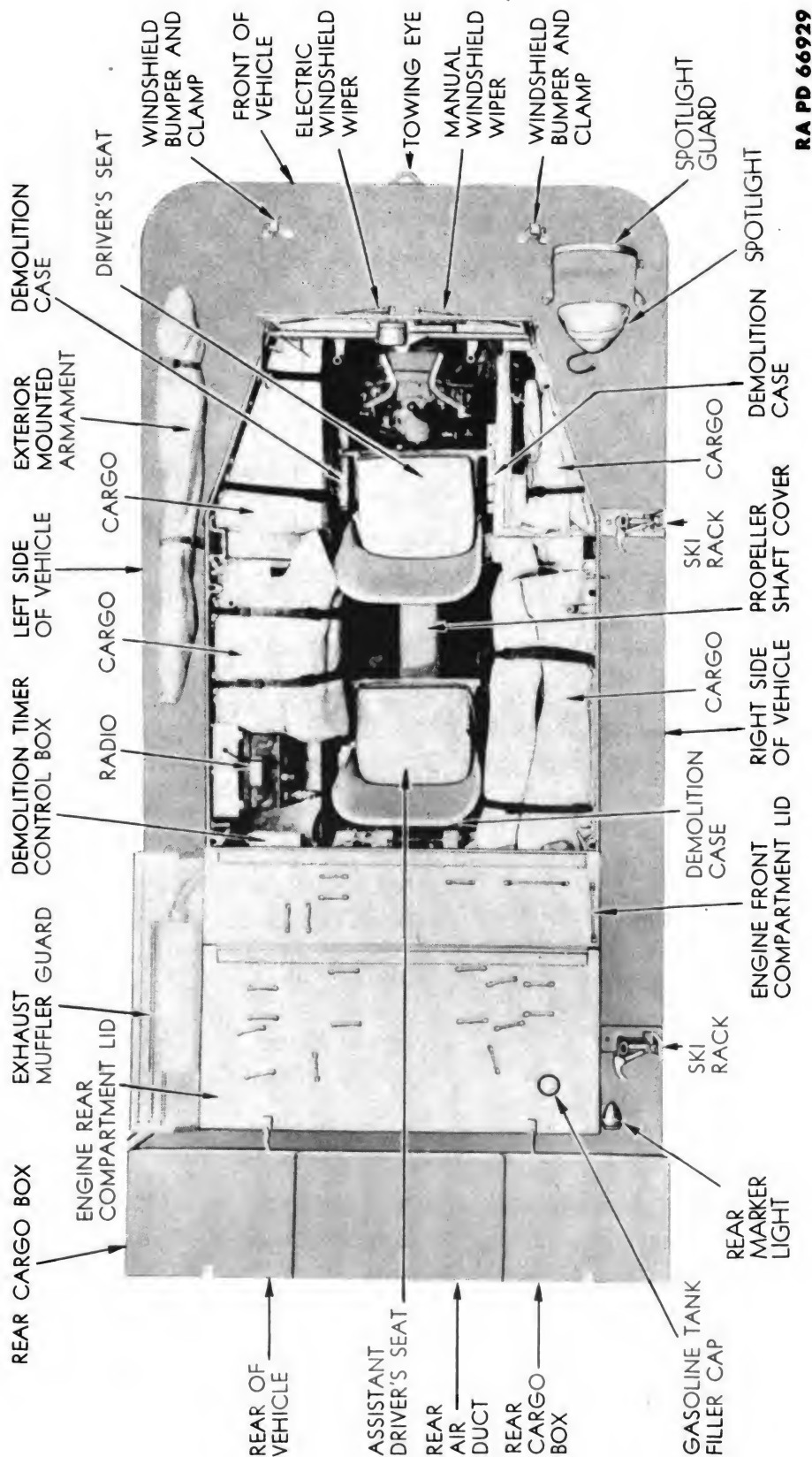
**HULL**

	<b>Paragraph</b>
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Trouble shooting .....	64
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Windshield and brackets .....	72
Spotlight guard .....	73
Bulkhead .....	74
Miscellaneous brackets, hooks, handles, loops, straps, covers, and drains .....	75

**63. DESCRIPTION AND DATA.**

**a. Description.** The hull proper is constructed of 18-gage metal, electrically welded so as to be waterproof, and to provide for flotation of the vehicle when in water over 3 feet 8 inches deep. The interior of the hull (fig. 135) is divided into two compartments: one for the driver and passenger; and the rear compartment, separated from the front by a sheet metal bulkhead, which houses the engine, fuel tank, battery, and radiator. The driver and passenger compartment is covered by a fabric top equipped with side and rear windows, and is supported by two top bows; while the engine compartment is covered with two hinged metal lids. Provision is made for draining water or oil from both the front and rear compartments by drain plugs. No armor plating is provided, except at side walls of air outlet duct and front walls of cargo boxes. A spotlight and rear marker light are supplied for night driving. Two windshield wipers, one electric and one manual, are provided. Ski racks are located in right deck. The vehicle is equipped with a pintle hook at rear and a towing eye at front. Cargo straps are provided for carrying equipment.

# HULL



RA PD 66929

**Figure 135 — Cargo Carrier M28 — Top**



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**b. Data.**

Weight of vehicle with oil, fuel, and water . . . . .	3390 lb
Over-all length . . . . .	132 $\frac{1}{4}$ in.
Over-all width . . . . .	60 in.
Over-all height (ground to top of windshield) . . . . .	67 in.
Over-all height (top and windshield folded) . . . . .	49 in.
Ground clearance . . . . .	12 in.
Turning circle (approximate) . . . . .	24 ft
Unit pressure (5-in. snow penetration) . . . . .	1.39 lb per sq in.

**64. TROUBLE SHOOTING.**

**a. Hull Leakage.**

Possible Cause	Possible Remedy
Holes in bottom of hull.	Weld hull.
Drain plugs loose.	Tighten plugs.
Leakage at axle shaft or carrier flange.	Tighten flange bolt nuts, or install new gaskets.
Starter crank hole cover leaking or missing.	Tighten or replace cover.

**b. Hull Brackets out of Alinement.**

Hull cracked at bracket weld.	Straighten or weld bracket.
-------------------------------	-----------------------------

**c. Top Leakage.**

Top torn.	Repair or replace top.
Top worn excessively.	Repair or replace top.
Top insecurely lashed.	Fasten top securely.
Windows broken.	Replace windows.

**d. Seats Noisy.**

Seats insecurely fastened.	Tighten seats.
Seat back bracket broken.	Replace or repair bracket.
Seat bottom broken at weld.	Reweld seat.

**e. Lids Noisy.**

Fastening screws or bolts loose.	Tighten screws or bolts.
Fastening screws or bolts missing.	Replace screws or bolts.

**65. HULL.**

**a. Cleaning of Hull.** Clean the hull both externally and internally with water under pressure. More satisfactory results will be obtained if hot water is used.

**b. Inspection and Repair.** Inspect the hull for cracks or tears which might cause water leakage. Examine the bogie assembly support brackets

## HULL

(outriggers) and upper track guide wheel brackets for alinement and breaks. If cracks or tears are discovered, weld or straighten as required. Examine ski racks to ascertain if properly welded and secured. If not, tighten or reweld as required. Repairs to the hull will consist primarily of welding breaks, holes, or cracks and of straightening bent outriggers or guide brackets by heating and alining.

### 66. TOP AND BOWS.

a. **Top.** Two types of material are used in the tops, either heavy duck material or balloon fabric. Either cotton braided cord, or flexible steel cable lashings are used.

b. **Bows.** The bows are constructed of tubing, and bent to the proper shape.

c. **Removal of Top.** Remove rear lashing cables which hold top assembly to coaming, and then remove side coaming lashings. Fold top from rear to front and remove windshield lashings last.

d. **Removal of Top Bows.** Remove cotter pins holding bows in sockets, then lift bows up and out of sockets (fig. 136).



RA PD 66903

**Figure 136—Removing Top Bows**



## HULL

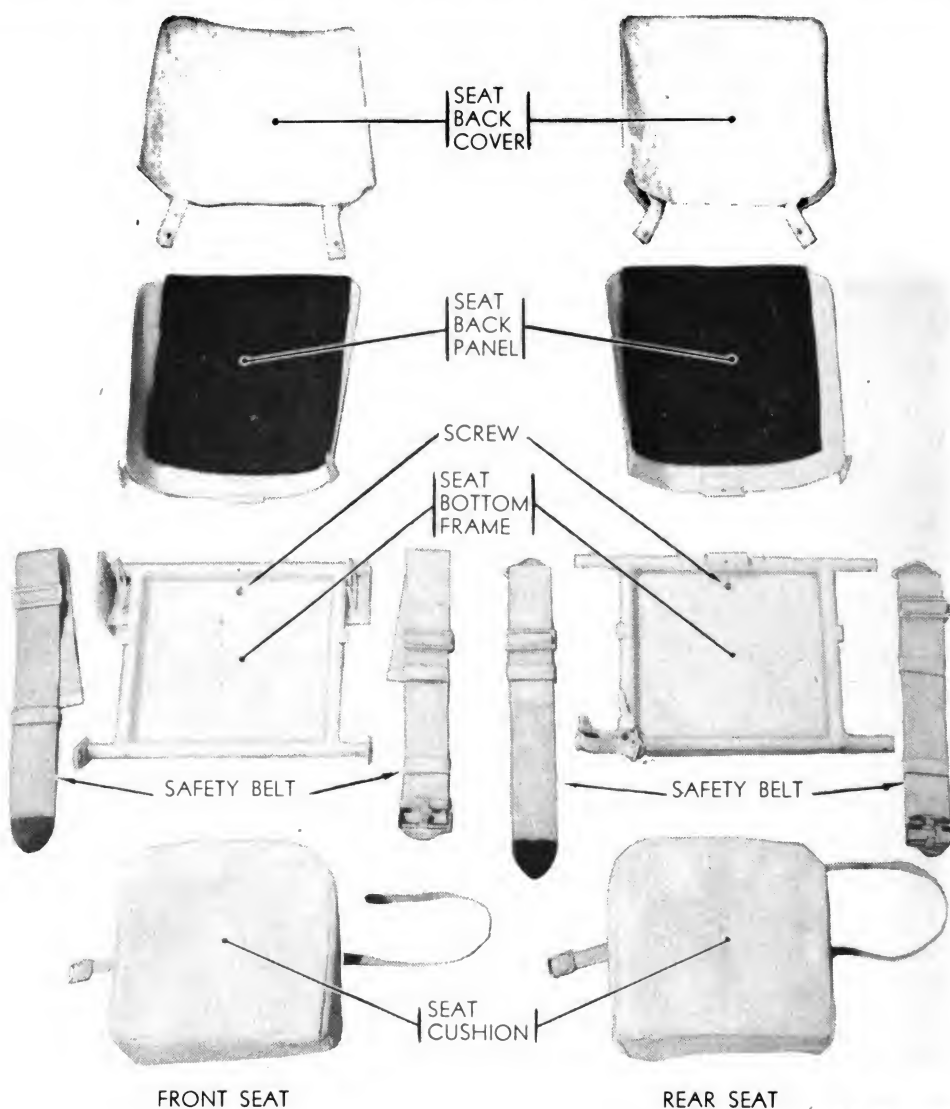


RA PD 66904

**Figure 138—Removing Rear Seat Assembly**

trace of grease, oil, or other foreign matter remains. Cut two patches of proper shape and of ample size from clean material. Mix proper proportions of suitable adhesive cement (similar to Goodrich A-52-B and A-53-B). *NOTE: Mix only quantity for repair at hand, as same mixture will not be satisfactory for further use.* Apply a thin even coating of adhesive cement mixture to both patches and on area to be repaired. Use a piece of fiber or wood block under patch or top when applying cement. Allow ample time for adhesive cement to dry. Stretch section to be repaired to its normal tension when installed. Allow 12 to 24 hours for the patch to dry before the repaired top or curtain is put into service.

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RA PD 66913

**Figure 139—Parts of the Front and Rear Seats**

i. **Installation of Top Bows.** Install top bows in their sockets, and install cotter pins. Note that bow having four eyelets at middle is installed in front.

j. **Installation of Top.** Place top in position over bows and lash it into place at windshield first, and then stretch it to rear, and fasten rear and sides. The vehicle should always be entered on left side (side opposite ski racks).

## 67. SEAT ASSEMBLIES.

a. **Description.** Seats are of tubing and sheet metal construction, having removable backs which are padded. Cushions held in place by



## HULL

web straps are supplied for the seats. The front seat is adjustable. Removable web safety belts are included. A map pouch is provided on back of front seat.

**b. Removal of Seats.** Remove cap screws holding the front seat to hull and lift seat assembly out of vehicle (fig. 137). The rear seat is not adjustable and is held in frame brackets by cotter pins. Remove cotter pins and lift rear seat out of vehicle (fig. 138).

**c. Disassembly of Seat Assemblies.** Disassemble seat cushion from seat bottom by unfastening snap buttons on holding straps, and remove cushions. Remove sheet metal screws holding seat back flange to seat frame, tip seat back forward, and lift seat back from frame. The seat back covering is removed from seat back by unfastening holding straps at bottom, and pulling the cover up and off. Remove safety belts from seat bottoms (fig. 139).

**d. Inspection and Repair.** Inspect seat bottoms for broken welds in frames, and make certain that sheet metal bottom has not broken loose from frame. Reweld any broken places. Inspect seat back coverings for dirt, grease, and other foreign substances, and wash with soap and water to clean, if necessary. Inspect back proper for cracks or breaks, and reweld if necessary. Examine safety belts for broken cords or buckles, and replace if not satisfactory for further service.

**e. Assembly of Components.** Assemble seat cushions to seats, strapping them into position. Make sure that safety belts are in position on seat bottoms. Slip seat back covers over seat backs and fasten into position with turn buttons on fastening straps. Engage the ears on seat backs in seat frames, and tip seat back to proper position. Install sheet metal screws through seat back flange and into seat frame, and tighten securely.

**f. Installation of Seat Assemblies.** Install front seat assembly by attaching it to hull with cap screws, fastening it into the most comfortable driving position. Install rear seat assembly by lowering it into holding brackets, and fasten with cotter pins.

## 68. ENGINE COMPARTMENT LIDS AND SCREENS.

**a. Description.** Two lids are provided for the engine compartment. The smaller or forward hinged lid serves as an air intake and must be open at all times while the engine is running. To prevent the entrance of leaves, broken tree branches, and similar objects, a screen is provided directly under the smaller lid. The lid fastens to the center bulkhead by nine fastening bolts. Suitable brackets are provided which, by means of knurled fastening knobs, hold the lid in any desired open position. It is essential that the holding sector arm be inspected to determine whether or not it will function as intended and whether knobs will tighten sufficiently to hold lid in desired position. The rear, or large lid, covers the engine proper and should remain closed unless it is desired to gain access to engine compartment. The front of the lid is hinged

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and fastened to vehicle by bolts; lid hooks secure lid at rear. The top of the lid is equipped with loops for cargo carrying straps.

b. **Removal of Engine Compartment Front Lid Screen.** Unscrew and remove engine compartment front lid, adjusting sector arm knob at each side, and move lid to completely raised position. Remove the three machine screws that secure the front lid screen to brackets on engine compartment rear lid hinge support. Note that a lock washer and flat washer are used between nut and under side of bracket; also, that a double toothed lock washer is used between screen and top side of bracket to assure complete grounding at these points. Repeat operation at the three screws holding front of screen to brackets on compartment front lid hinge, and remove the screen (fig. 140).



RA PD 49344

**Figure 140—Removing Engine Compartment Front Screen**

c. **Removal of Engine Compartment Front Lid.** Remove the two lid cross bracket cap screws and lock washers at each end of the bracket. Remove bolt, nut, lock washer, and flat washer securing each end of lid hinge and cross brackets to an angle bracket welded on deck coaming. Remove the nine cap screws, lock washers, and flat washers holding cross bracket to bulkhead. Lift lid with hinge and cross bracket off vehicle (fig. 141).

d. **Removal of Engine Compartment Rear Lid.** Remove engine compartment lid and hinge support by taking out the four bolts and nuts with lock washers (two on each side), which hold lid hinge to deck coaming. Lift off lid and hinge assembly (fig. 142).

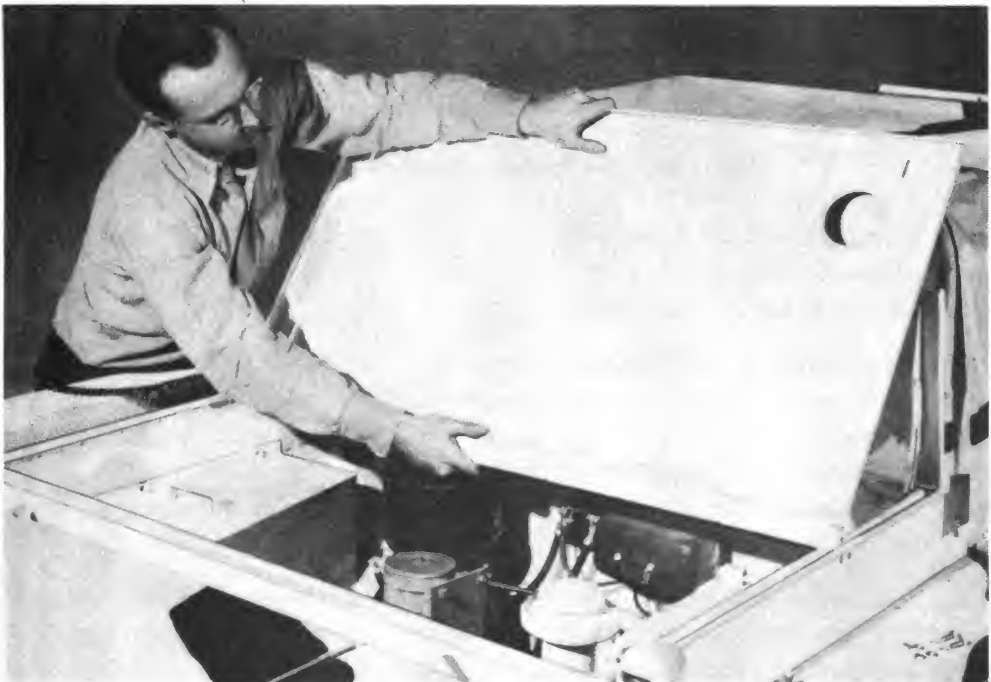
## HULL



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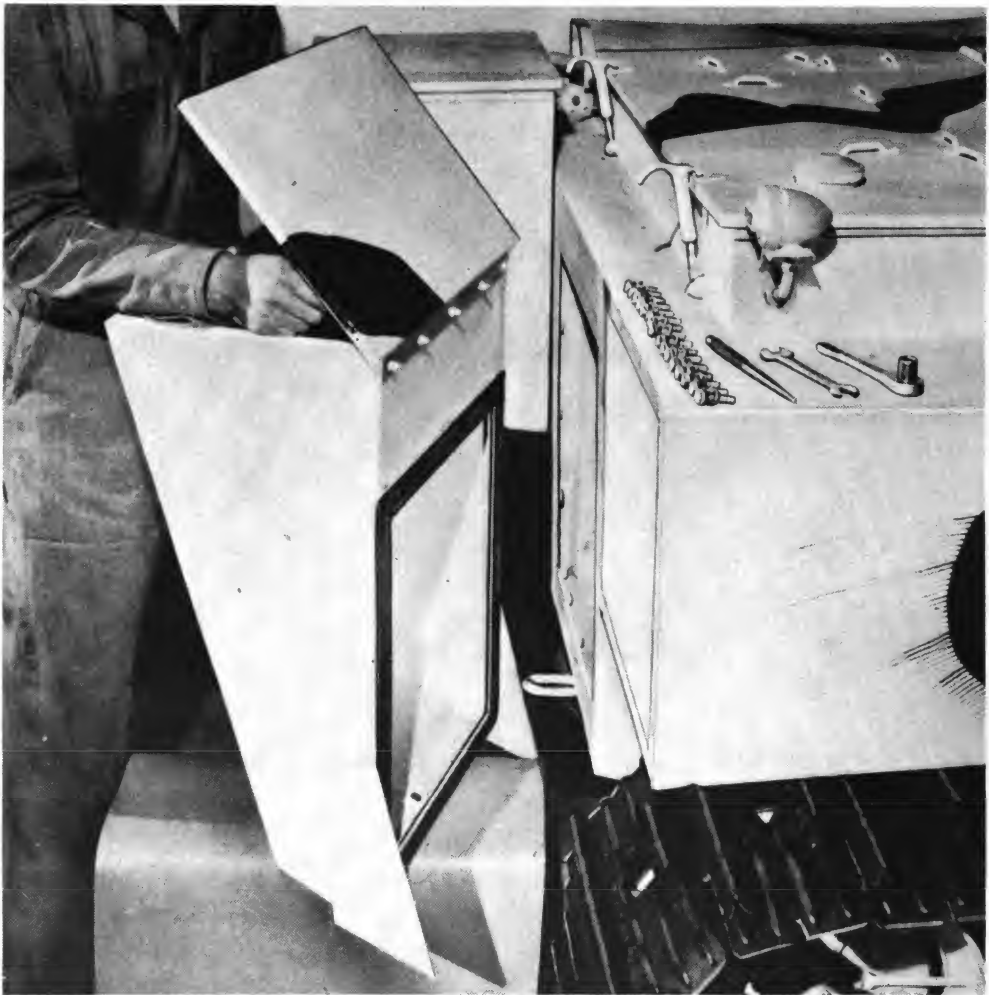
**Figure 141—Removing Engine Compartment Front Lid**

e. **Inspection and Repair.** Inspect lids, hinges and fastenings, and screen for damage; repair by rewelding; or replace any parts that cannot be repaired satisfactorily.



RA PD 49346

**Figure 142—Removing Engine Compartment Lid**

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RA PD 49361

**Figure 143—Removing Rear Air Duct**

**f. Installation of Engine Compartment Rear Lid.** Place lid hinge in position on deck coaming, and fasten with bolts, lock washers (two on each side), and nuts. Tighten nuts securely.

**g. Installation of Engine Compartment Front Lid.** Place lid, with hinge and cross bracket, in position and fasten cross bracket to bulkhead with nine cap screws. Be sure to install flat and lock washers on cap screws. Fasten each end of lid hinge and cross bracket to angle bracket welded to deck coaming with the bolt, flat and lock washers, and nuts; and tighten securely.

**h. Installation of Engine Compartment Front Lid Screen.** With front lid completely raised, place screen in position and install the three machine screws holding screen to brackets on engine compartment lid hinge support. Be sure to install lock and flat washer between nut and under side of bracket; and double toothed lock washer, between

HULL

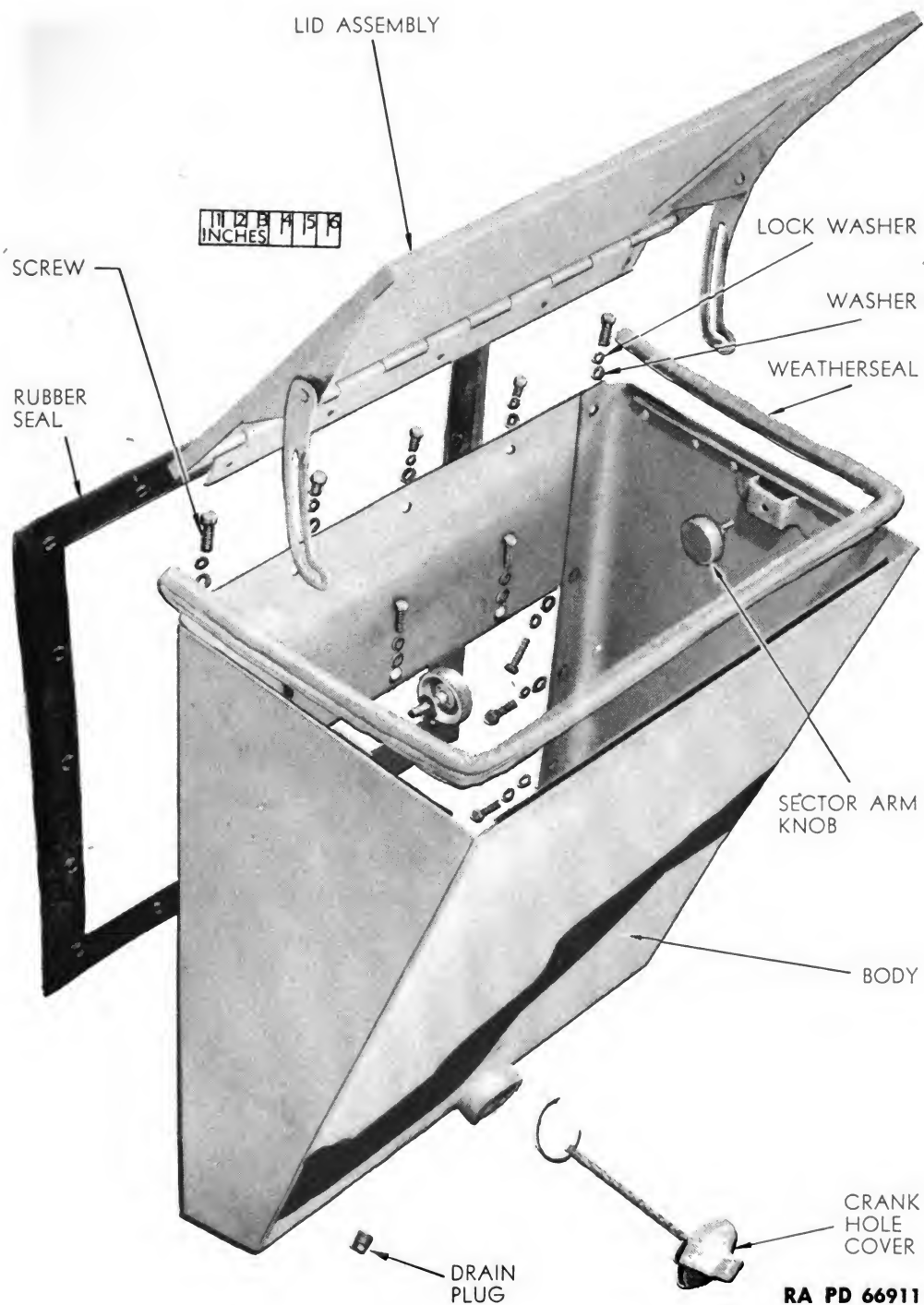
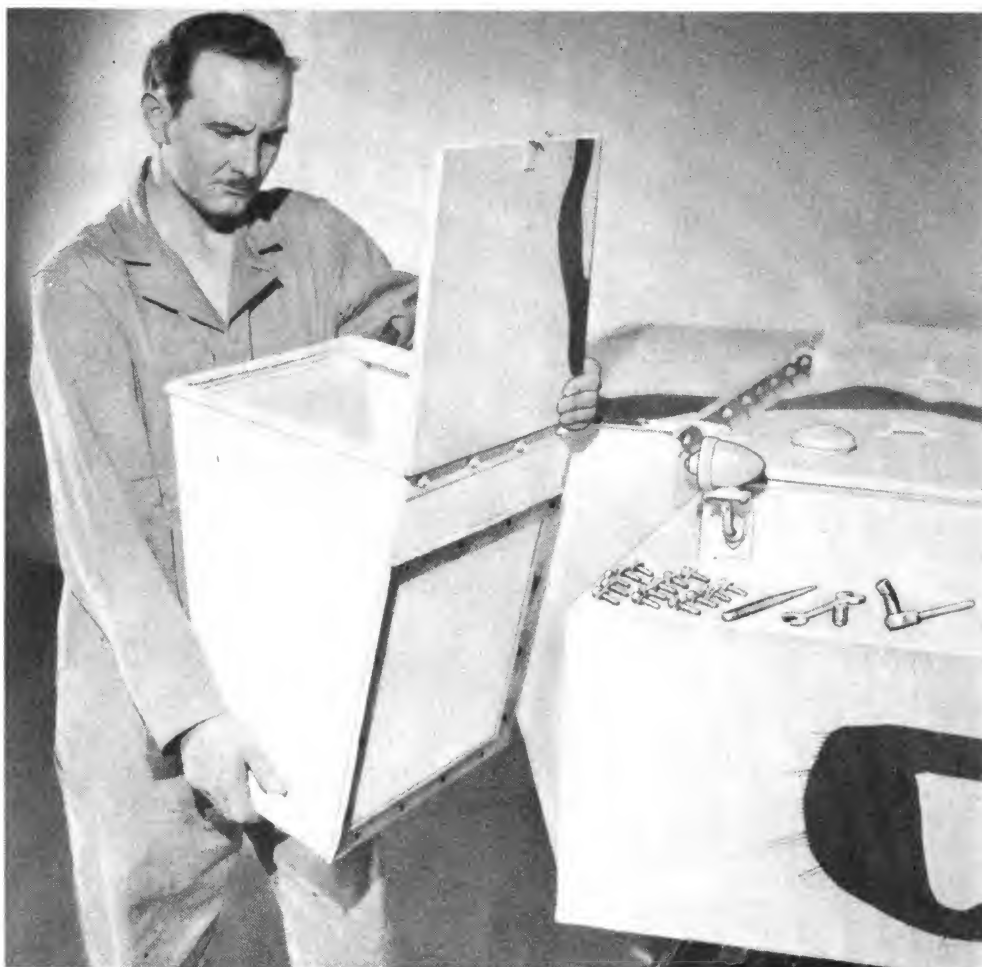


Figure 144—Rear Air Duct Parts



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RA PD 49362

**Figure 145—Removing Cargo Box Assembly**

screen and top side of the bracket. Install the three screws holding front of screen to brackets on compartment front lid hinge.

**69. REAR AIR DUCT ASSEMBLY.**

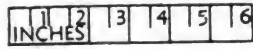
a. **Description.** The air duct assembly is used to prevent the entrance of water into the hull, if the vehicle is operated in water above the bottom of the radiator, and to protect the radiator. The duct is constructed of light armor plate material, and is equipped with a plug for draining any water that may accumulate. A starter crank hole with a sealed cap is provided.

b. **Removal of Rear Air Duct.** Remove the 16 cap screws, lock and flat washers holding air duct to hull, and lift entire assembly from vehicle (fig. 143).

c. **Disassembly of Rear Air Duct.** Disassemble lid and adjusting bracket arms by removing bolts holding lid hinge to air duct proper.

HULL

LID ASSEMBLY



NUT

LOCK  
WASHER

RUBBER  
SEAL

WASHER

WASHER

BOLT

SCREW

WEATHERSEAL

LOCK  
WASHER

ARMOR  
PLATE

NUT

FASTENER

WASHER

CARGO  
BOX

RA PD 66910

Figure 146—Cargo Box Parts

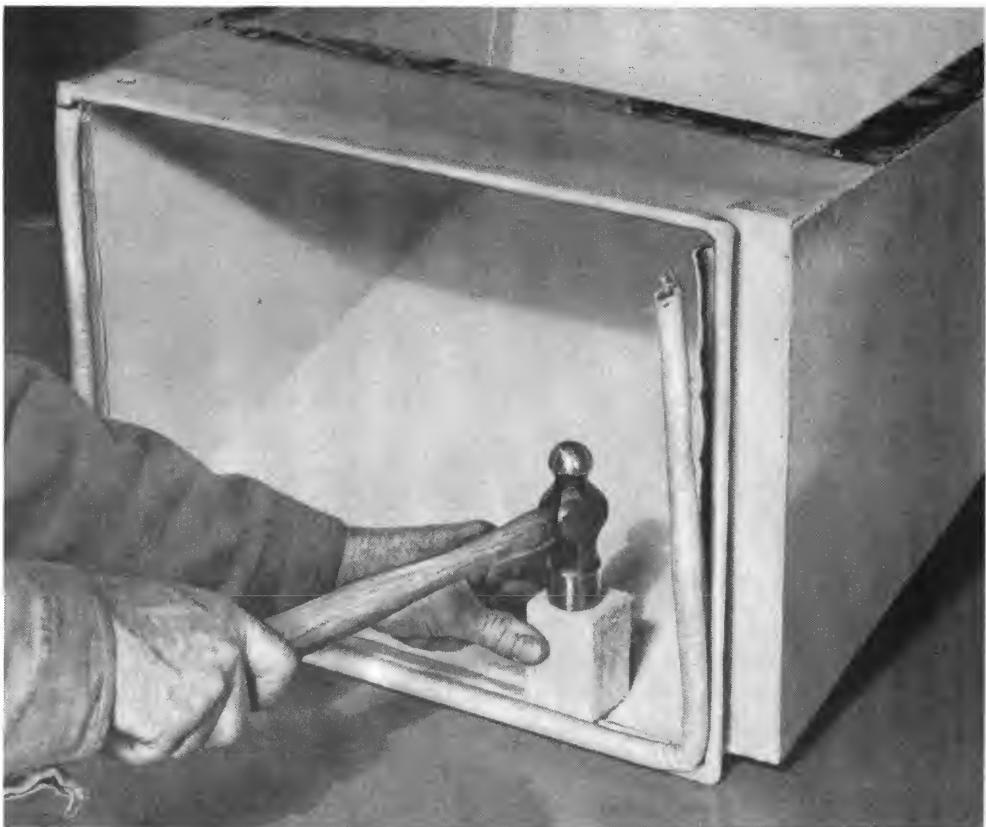
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If it is necessary to remove padded weatherstripping from outer edges of air duct, this can be done by prying the crimped flange inward, and away from edge of duct. Water leakage between hull and air duct is prevented by a heavy gasket. In the event of adhesion, either to duct or hull, the gasket can be removed with a putty knife or screwdriver blade. The starter crank hole cover is removed by twisting it counter-clockwise. The holding chain can then be disengaged.

**d. Inspection and Repair.** In the event inspection reveals cracks or holes in duct, they may be repaired by welding. Paint the surface after welding. If padded weatherstripping is damaged, replace with new material. Examine the hull to air duct gasket; and if damaged, replace it. Examine the starter crank hole cover, and if damaged, or if seal inside cover has deteriorated, procure a new cap.

**e. Assembly of Rear Air Duct.** To reassemble weatherstripping to air duct, insert narrow portion of material in flange slot and tighten with wood block and hammer. Install the starter crank hole cover, making sure that spring wire ring is properly inserted to prevent loss of cap.

**f. Installation of Rear Air Duct.** If necessary, install a new gasket, and assemble air duct to hull with the 16 holding screws, plain and



RA PD 66914

**Figure 147—Installing Weatherstrip**

## HULL

lock washers. Make certain that adjusting arm brackets operate properly. Be sure that drain plug is installed and tightened.

### 70. CARGO BOX ASSEMBLIES.

**a. Description.** The two cargo boxes located at rear of vehicle are equipped with lids, and are fastened to the hull. They are, as the name implies, for the purpose of carrying supplies, tools, etc.

**b. Removal of Cargo Box Assemblies.** To remove cargo boxes, either right or left, it is only necessary to remove fastening screws which hold them to hull (fig. 145).

**c. Disassembly, Inspection, and Repair of Cargo Box Assemblies.** The only disassembly that can be made of cargo boxes is to remove lids by removing the bolts holding hinge bracket to box. Inspect cargo boxes and lids for cracks or holes, and make any necessary repairs by welding, or bumping out any dents. Inspect the box to hull gasket and if not satisfactory, replace the gasket. In the event the weatherstripping is damaged, procure new material, and install by inserting narrow portion of stripping in the flange slot; tighten with wood block and hammer (fig. 147).

**d. Installation of Cargo Box Assemblies.** To install cargo boxes, install a new gasket if necessary, place the box in position, and fasten securely to hull with the holding screws.

### 71. MUFFLER GUARD.

**a. Description.** The muffler guard is constructed of heavy wire mesh and is provided for the purpose of preventing muffler damage from tree branches or other objects striking the muffler.

**b. Removal of Muffler Guard.** Remove guard from vehicle by removing the four bolts, nuts, lock and flat washers that hold the guard in position (fig. 148).

**c. Inspection and Repair.** Replace mesh if broken. If the guard is bent out of shape, straighten before reinstalling.

**d. Installation of Muffler Guard.** Install guard by fastening it in position with the four bolts, nuts, plain and lock washers. Tighten the nuts securely.

### 72. WINDSHIELD AND BRACKETS.

**a. Description.** The windshield assembly consists of the frame and safety glass with attaching brackets and supporting arms. Disassembly of the windshield is not possible, due to the method of sealing the glass in the frame to prevent loosening from vibration.

**b. Removal of Windshield Assembly.** If inspection reveals the necessity for removal of windshield assembly, loosen top lashings and fold top back, out of the way. Loosen the knurled knobs that hold supporting brackets on inside of hull coaming. Remove the bolts, nuts,

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plain washer spacers, and lock washers that hold windshield, at the extreme right and left front corners, to the hull. Disconnect windshield wiper wiring at connector plug and remove windshield assembly (fig. 149).

c. **Disassembly of Windshield Assembly.** Remove electric windshield wiper assembly (par. 86). Loosen screw holding manual wiper arm to shaft, and remove arm and blade. Take off shaft end nut, and remove handle and shaft from windshield frame.

d. **Inspection and Repair.** No repair is possible to windshield



RA PD 66908

**Figure 148—Removing Muffler Guard**



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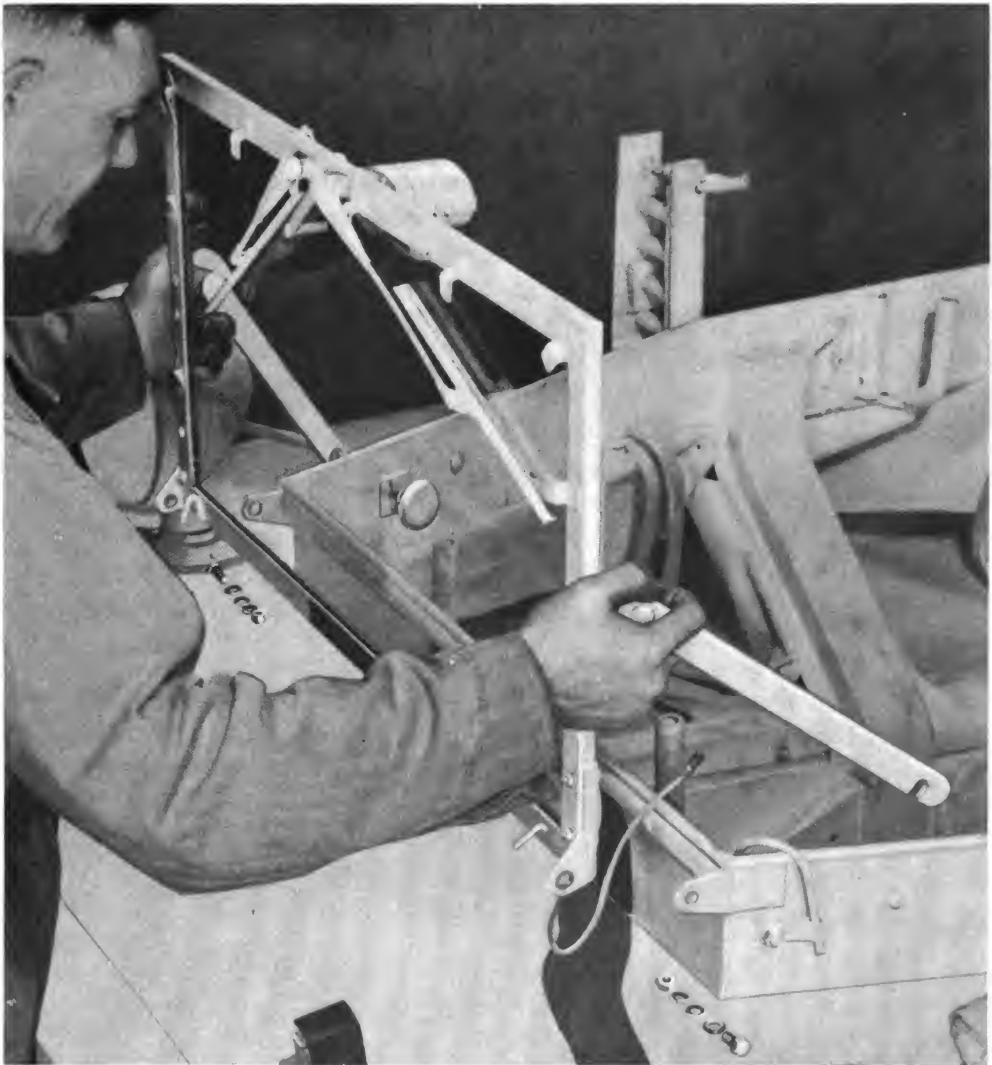
frame or glass. If windshield assembly is not satisfactory for further service, replace it.

**e. Assemble Wipers to Windshield Assembly.** Insert manual wiper shaft through windshield upper frame, and install shaft end nut. Install wiper arm and blade on shaft and tighten the arm holding screw securely. Install the electric windshield wiper (par. 86).

**f. Installation of Windshield Assembly.** Place windshield assembly in position and install bolts, nuts, and washers. Slip supports into position and tighten the knurled knobs securely. Roll the top forward to windshield and lash securely into position.

### 73. SPOTLIGHT GUARD.

**a. Description.** The spotlight guard is provided to reduce the possibility of damage to the spotlight. It is constructed of heavy strap iron suitably formed to provide maximum protection.



RA PD 66906

**Figure 149—Removing Windshield Assembly**

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b. **Removal of Spotlight Guard.** The spotlight guard is held in position by bolts, one on each of the four supporting straps, which go through the hull body. To remove, it is necessary to remove only the nuts and lock washers, and lift off the guard.

c. **Inspection and Repair.** If guard is twisted, it can be straightened after removal. If guard is broken, repair by welding, or replace.

d. **Installation of Spotlight Guard.** Place guard in position and fasten securely on hull with bolts and nuts.

**74. BULKHEAD.**

a. **Description.** The sheet metal bulkhead serves to separate the engine compartment from the operator's compartment, and prevent engine fumes from entering the cockpit. It also serves as a mounting for certain electrical units and wiring, and as an auxiliary support for the hull.

b. **Removal of Bulkhead.** Remove engine compartment front lid and screen (par. 68). Remove top and bows (par. 66). Remove wires and cable at starter solenoid switch, after taking off the terminal nuts. Remove wires at terminals on current and voltage regulator, and on external filter. Bend down clip on offset at rear of bulkhead to unfasten primer lines from bulkhead. Remove the screw and nut which retain oil pipe and choke tube clip to bulkhead. Take out the eight cap screws holding left and right sides of bulkhead to bulkhead frame. Remove metal screw and clip to free the demolition wires on front of bulkhead. Turn and pull out plug on bottom of demolition timer control switch box and remove wire running through bulkhead from plug. Remove nut, lock washer, flat washer, and pull wiring harness clip off bolt to unfasten harness from rear of bulkhead. Push loose demolition wire through hole in bulkhead. Lift off bulkhead with starter solenoid switch, voltage regulator, fire extinguisher, and demolition equipment (fig. 150).

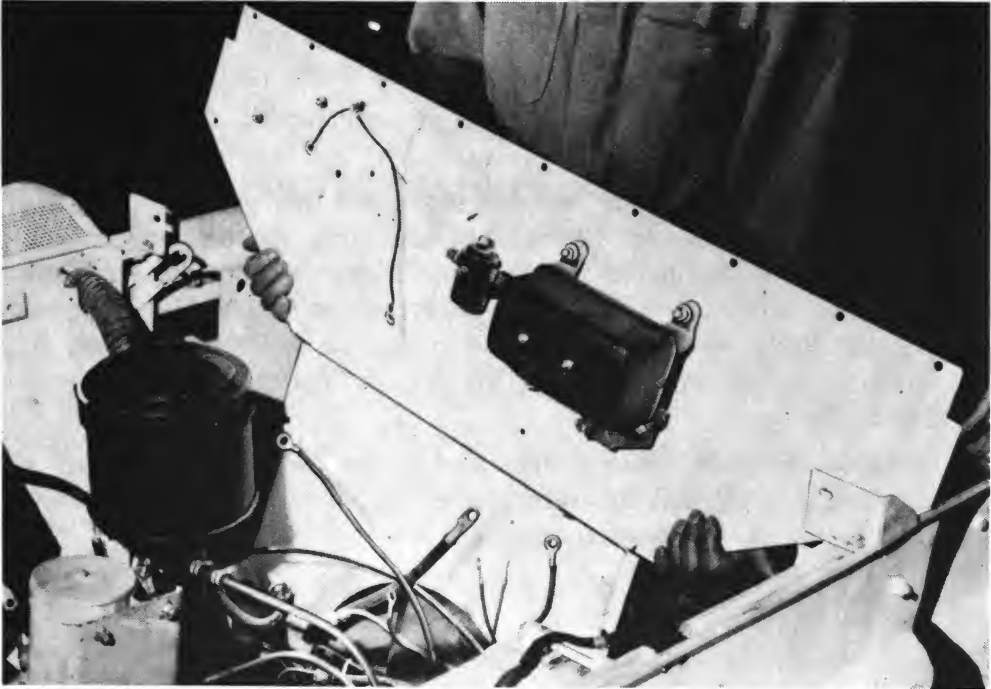
c. **Installation of Bulkhead.** Place bulkhead in position and fasten securely with the cap screws. Install all holding clips and connect all wires and lines. Install engine compartment front lid and front lid screen (par. 68). Install top and bows (par. 66).

**75. MISCELLANEOUS BRACKETS, HOOKS, HANDLES, LOOPS, STRAPS, COVERS AND DRAINS.**

a. **Brackets.** Examine brackets for cracks or breaks, and loose fastening bolts or rivets. If cracked or broken, repair by welding, or replace; if loose, tighten rivets or bolts.

b. **Hooks.** Inspect hooks for breaks and loose or weak springs and fastenings. In most cases it will be preferable to install a new part.

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RA PD 49407

**Figure 150—Removing Bulkhead**



RA PD 66907

**Figure 151—Removing Covers**

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c. **Handles.** Inspect handles for breaks, and loose fastening bolts or rivets. Replace parts if broken, and fasten securely.

d. **Loops and Straps.** Replace loops or straps if broken, torn, or frayed.

e. **Covers.** The covers referred to are those for guns, spotlight and cargo space inside vehicle. Those that are dirty should be cleaned by washing with mild soap and warm water. Repair or replace covers that are torn or otherwise damaged. To remove cargo covers spread retainer and lift out the cover (fig. 151). To install cargo covers, insert bead into retainer, and bend retainer lip back to hold bead, using a hammer and wood block.

f. **Drains.** Inspect drain plates and plugs for proper fit and seal. Make certain that all gaskets are in place, in good condition, and properly coated with joint and thread compound.

## CHAPTER 5

## HULL AND HULL ELECTRICAL SYSTEM (Cont'd)

## Section II

## HULL ELECTRICAL SYSTEM

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## 76. DESCRIPTION AND DATA.

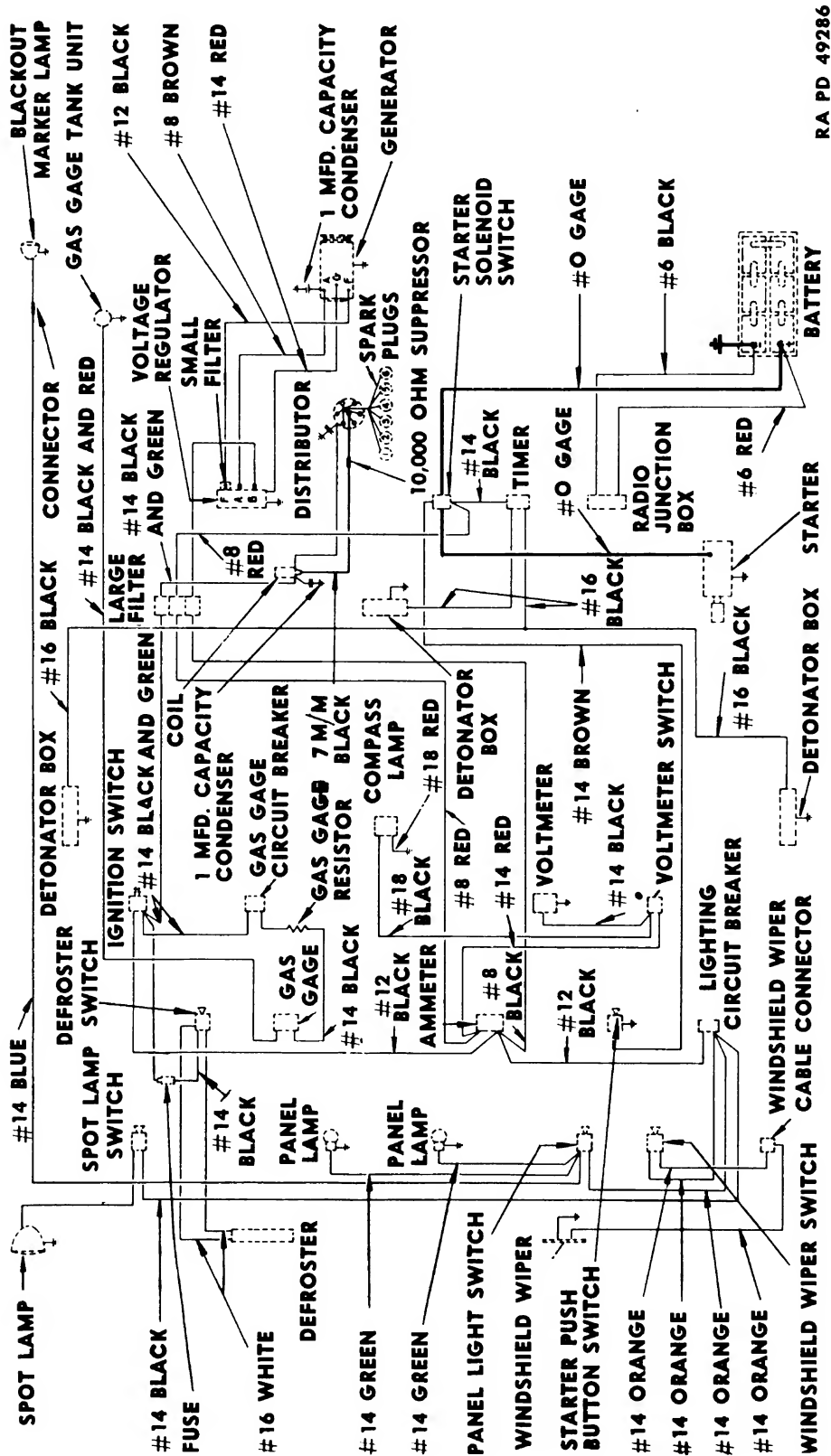
**a. Description.** The hull electrical system is of the single-wire-grounded type and consists of a heavy-duty battery, related wiring, voltmeter, compass and light, the several lights on the vehicle, the electric windshield wiper and defroster, and related operating switches. Since provision is made for radio installation, adequate grounding is extremely important, and is provided at all points where grounds are necessary. Throughout this section, the face of the instrument panel or gages as observed from the driver's seat will be referred to as the front. References to the rear (back) of the panel or instruments, relate to the side at which the mountings and electrical terminals are located.

**b. Data.**

Spotlight .....	Make—Trippe Speedlight
Spotlight lamp .....	Model—C3
Spotlight lamp candle power .....	102½, 12-16 volts
Panel lights .....	2
Panel light lamps .....	Mazda 53
Panel light lamp candle power .....	1, 12-16 volts
Windshield wiper (electric—12 volts) .....	Bosch, WWA12B-143
Battery .....	Willard—RHD-19-6
Battery capacity .....	153 ampere hour
Voltmeter .....	(Range) 8-16 volts
Windshield defroster .....	Make—Signal Mfg. Co.



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RA PD 49286

Figure 152—Wiring Diagram

## HULL ELECTRICAL SYSTEM

### 77. TROUBLE SHOOTING.

#### a. No Current from Battery to Operate Lights or Accessories.

Possible Cause	Possible Remedy
Battery discharged.	Replace or recharge battery, either with battery charger or by starting engine with starter and allowing engine to run sufficient time for generator to charge battery.
Short in wiring system due to frayed or broken cable.	Locate defective wire, and replace wire or harness assembly.
Incorrect wiring hook-up.	Rewire according to wiring chart.
Defective battery.	Replace battery.

#### b. Lamps Fail to Light.

Lamp defective.	Replace lamp.
Lamp terminals dirty or corroded.	Clean terminals.
Loose connections.	Tighten connections.
Defective switch.	Replace switch.
Battery discharged.	Replace or recharge battery.

#### c. Instruments Fail to Operate.

Battery discharged.	Replace or recharge battery.
Poor ground connection.	Clean and tighten connection.
Loose terminal connections.	Tighten connection.
Defect in unit.	Replace unit.

#### d. Accessories Fail to Operate or Operate Incorrectly.

Battery discharged.	Replace or recharge battery.
Wiper runs hot.	Replace wiper.
Wiper arm and blade runs slow.	Inspect wiper arm for tightness to body shaft.
Defroster burned out.	Replace defroster.
Defroster plug wire broken.	Replace wires.

### 78. BATTERY.

**a. Description.** The battery is a Willard, 12-volt, 6-cell, 19-plate, heavy-duty type. It has a capacity of 153 ampere hours and is equipped with the "safety-fill" type cap for each cell, to prevent overfilling. The battery is insulated for protection against freezing, and to assure maximum operating efficiency, a heating unit is incorporated in the battery compartment.

**b. Removal of Battery.** Remove battery compartment cover by taking out the seven cap screws, two bolts and nuts, flat washers, and lock washers that hold cover in place. With compartment cover off,

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loosen cable terminal nuts, and remove terminals from battery posts. Remove hold-down clamp frame nut at each end of battery, lift off frame, and remove battery from compartment.

**c. Cleaning of Battery.** After plugging vents in cells, clean battery with a solution of soda ash (8 oz to 1 gal of water), or baking soda (1 lb per gal of water). After washing with solution until all traces of acid, dirt, or corrosion have been removed, flush case with cold water. Clean cable terminals with solution and if necessary, use a wire brush or suitable tool to assure a clean connection. Remove plugs from cell vents.

**d. Inspection and Repair of Battery.** Inspect battery case for leaks or cracks, and determine specific gravity by a hydrometer reading. If the reading is below 1.280, recharge, or replace battery with one that is fully charged. If battery case is cracked, repair or replace battery.

**e. Cold Weather Maintenance of Battery.** A partially discharged battery may freeze in winter; therefore, in cold weather keep battery fully charged, particularly if vehicle is parked or stored in a cold place for any length of time. The freezing point of electrolyte depends on its specific gravity, and when a battery is fully charged, the electrolyte will remain liquid at extremely low temperatures. If a fully charged battery stands idle for an extended period it will discharge slowly to a point where the solution will freeze. If vehicle is to be stored for a long time without heat in very cold weather, remove battery and place it in wet storage. When water is added to battery, and has not been mixed with electrolyte, it may freeze if battery is exposed to low temperatures. Batteries that have been frozen may be thawed in a room kept at normal temperature (60° to 70°F). The battery may be serviceable if freezing has not been too severe. The freezing points of various specific gravities of electrolyte in discharged batteries are as follows:

Specific Gravity	Freezing Temperatures
1.220	−31°F (−30°C)
1.185	− 8°F (−22°C)
1.150	+ 5°F (−15°C)
1.100	+18°F (− 8°C)
1.000 (water)	+32°F ( 0°C)

**f. Installation of Battery.** Install battery in vehicle, place hold-down frame in position, and install and tighten hold-down frame nuts. Coat battery terminal posts with petroleum jelly or light grease, and also coat cable clamps. Install clamps on the battery terminal posts, and tighten bolts securely. Install battery cover, and tighten screws.

**79. WIRING HARNESS.**

**a. Description.** The main harness connects the controls and gages on the instrument panel with the various units in the engine compart-

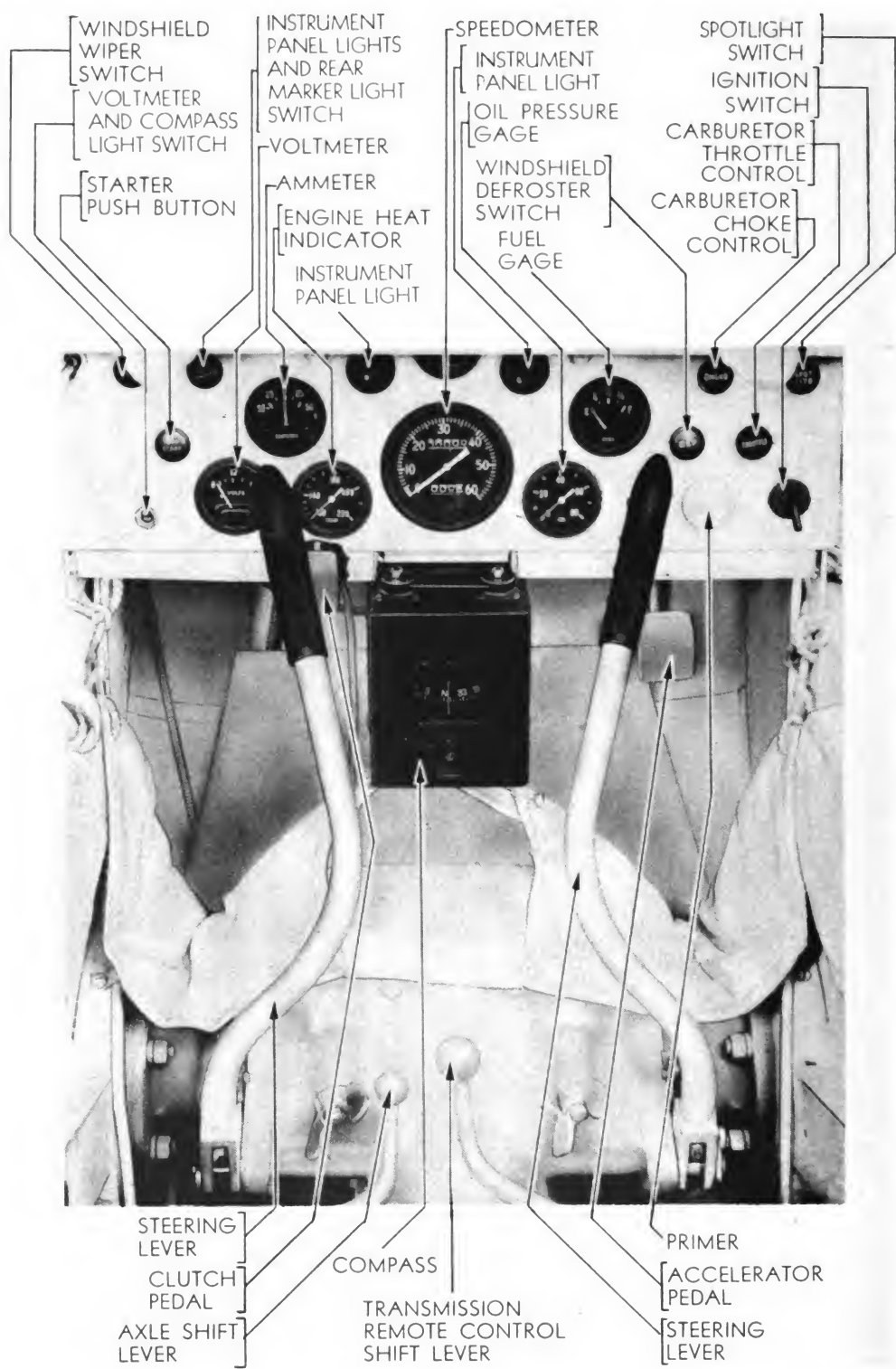
## HULL ELECTRICAL SYSTEM



RA PD 66912

**Figure 153—Removing Conduit Covers**

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HULL, AND HULL ELECTRICAL SYSTEM FOR CARGO CARRIER M28 (T15)



RA PD 66926

Figure 154—Instruments and Controls



## HULL ELECTRICAL SYSTEM

ment, and is carried in the channel or conduit on the right-hand side of the cockpit. The auxiliary harness contains the wires which connect the generator to the current and voltage regulator.

**b. Removal of Wiring Harness.** Disconnect and tag all terminal connections of main harness, and remove the conduit holding bolts on the right side, and the four screws from left side (fig. 153). Lift harness out of conduit and pull engine compartment end of wires forward through hole in bulkhead. The auxiliary harness is removed by disconnecting and tagging the wires at terminal ends, and removing the holding clips.

**c. Inspection and Repair (Main and Auxiliary Harness).** Inspect both main and auxiliary harness for evidence of worn or frayed coverings. Test each individual wire for proper current carrying capacity. If any wires are broken or a short is discovered, replace entire harness.

**d. Installation of Wiring Harness (Main and Auxiliary).** Insert engine compartment end of main harness wires through hole in bulkhead. Place harness in conduit, and install cover with bolts and nuts on right side, and screws on left side. Connect wires according to wiring chart (fig. 152). Place auxiliary harness in position in holding clips, tighten clip bolts, and connect wires according to wiring chart (fig. 152).

## 80. VOLTMETER.

**a. Description.** The voltmeter is used for testing the voltage present in the electrical system. It is operated by moving the switch handle and noting the reading of the indicator needle. The needle should register between 12 and 15 volts. Allow a slight delay for needle movement before reading.

**b. Removal of Voltmeter.** Remove nut and lock on back of instrument panel. Disconnect black wire from terminal post on back of voltmeter. Remove the two nuts from studs on voltmeter which hold clamp bracket to panel, and red wire to left mounting stud. Pull bracket off studs and remove voltmeter.

**c. Inspection and Repair.** Test voltmeter for proper operation with suitable equipment and if inaccurate, replace the unit.

**d. Installation of Voltmeter.** Place voltmeter in position, install two nuts on studs which hold clamp brackets to panel, connect red wire to left stud, and black wire to terminal post.

## 81. COMPASS AND LIGHT.

**a. Description.** The compass is of the sealed-liquid type and is mounted directly in front of the driver in a rubber-insulated bracket.

**b. Removal of Compass and Light.** Remove the four screws on each side which hold left and right side plates to compass case. Disconnect compass light wires by removing black wire from lower voltmeter switch terminal and red wire from left voltmeter mounting stud. Remove compass mounting bracket to hull brace bolt, nut, and spacer at

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compass bracket. Remove the two rear nuts with lock, and loosen forward two nuts and locks that secure compass mounting bracket to instrument panel support bracket. The forward nuts should then be removed with fingers of one hand while entire assembly is held with other hand.

c. **Inspection.** If, when testing with a compass of known accuracy, the vehicle compass is found to be inaccurate, refer compass to higher authority.

d. **Installation of Compass and Light.** Install compass mounting bracket to hull brace with bolt, nut, and spacer. Install the two front nuts with locks that secure compass mounting bracket to instrument panel support bracket. Install rear nuts with locks and tighten securely. Connect compass light by attaching black wire to lower voltmeter switch terminal, and red wire to left voltmeter mounting stud.

**82. INSTRUMENT PANEL LIGHTS.**

a. **Description.** The two lights are located near the middle and top of the instrument panel, and are operated by a switch located at the upper left of the instrument panel. The same control switch operates the rear marker light.

b. **Removal of Instrument Panel Lights.** Remove covers by pulling downward to spring cover loose from panel. To remove lamp, spring lamp socket out of body or shield by pulling sidewise on wire; then push in on lamp, turn it counterclockwise, and pull from socket.

c. **Inspection and Repair.** If the lamp fails to light, install a new lamp that has been tested. If the new lamp fails to light, inspect connections and wiring, and replace any parts of wiring found to be defective.

d. **Installation of Instrument Panel Lights.** Insert lamp in socket, push in, and turn clockwise to engage pins in socket. Place covers over lamp and socket, and push into position in panel.

**83. SPOTLIGHT.**

a. **Description.** A ball socket mounting of the light, located on the right front deck of the vehicle, permits adjustment of the light over a wide frontal range. An adjustment is provided for changing the final position of the cradled lamp socket axis. In addition to a full reflector, a deflector is used in the light for focusing. The operating switch for the spotlight is located at the upper right-hand corner of the instrument panel.

b. **Removal of Spotlight.** Loosen the post screw at the rear right side of spotlight switch and disconnect silver wire spade terminal from post. Remove light cable clip nut from light base bolts, spread cable clip at under side of light base bolt, and remove cable from clip. Remove the two metal screws which secure rubber grommet cap to deck. Pull

# HULL ELECTRICAL SYSTEM

RA PD 66898

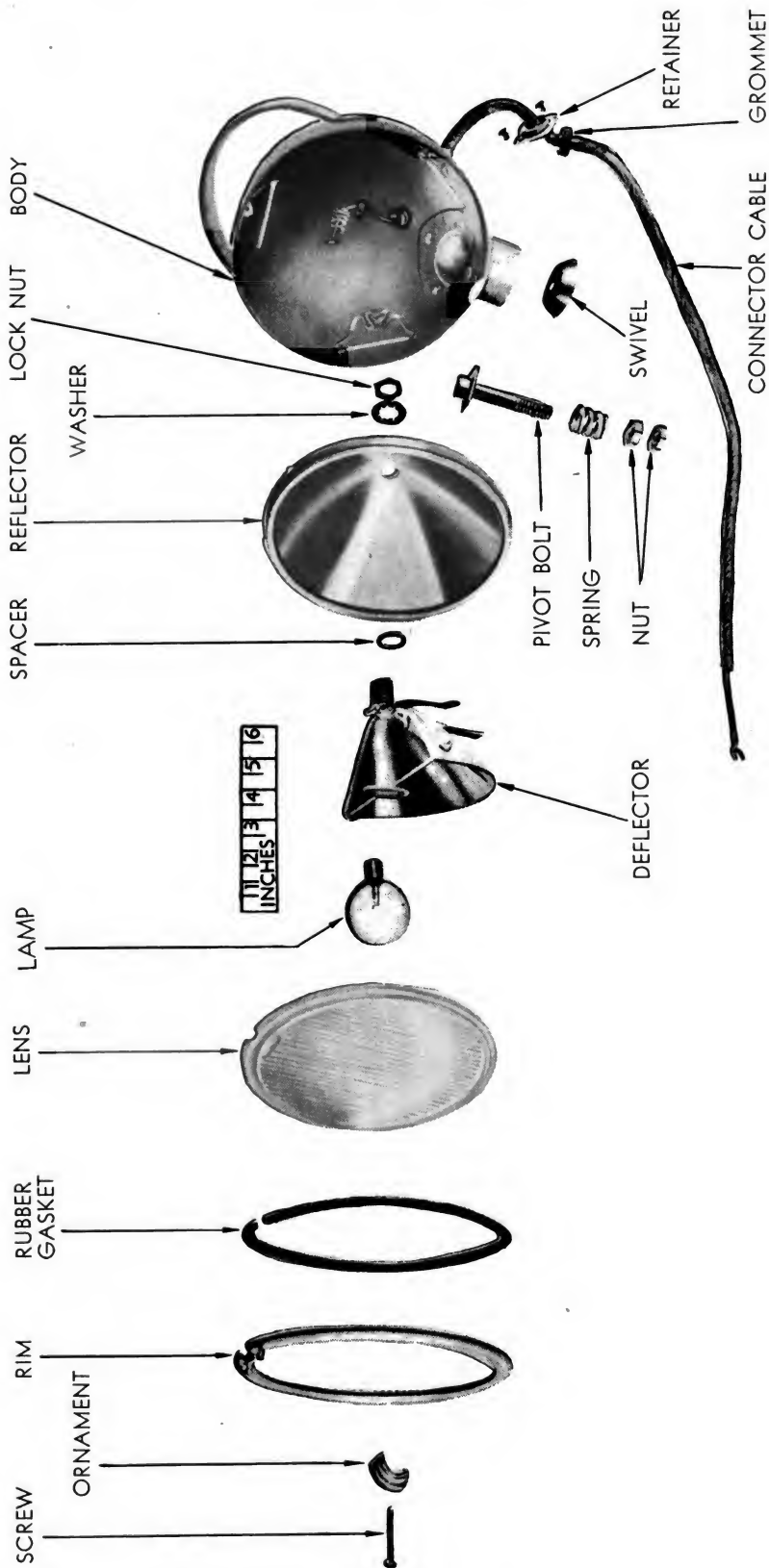
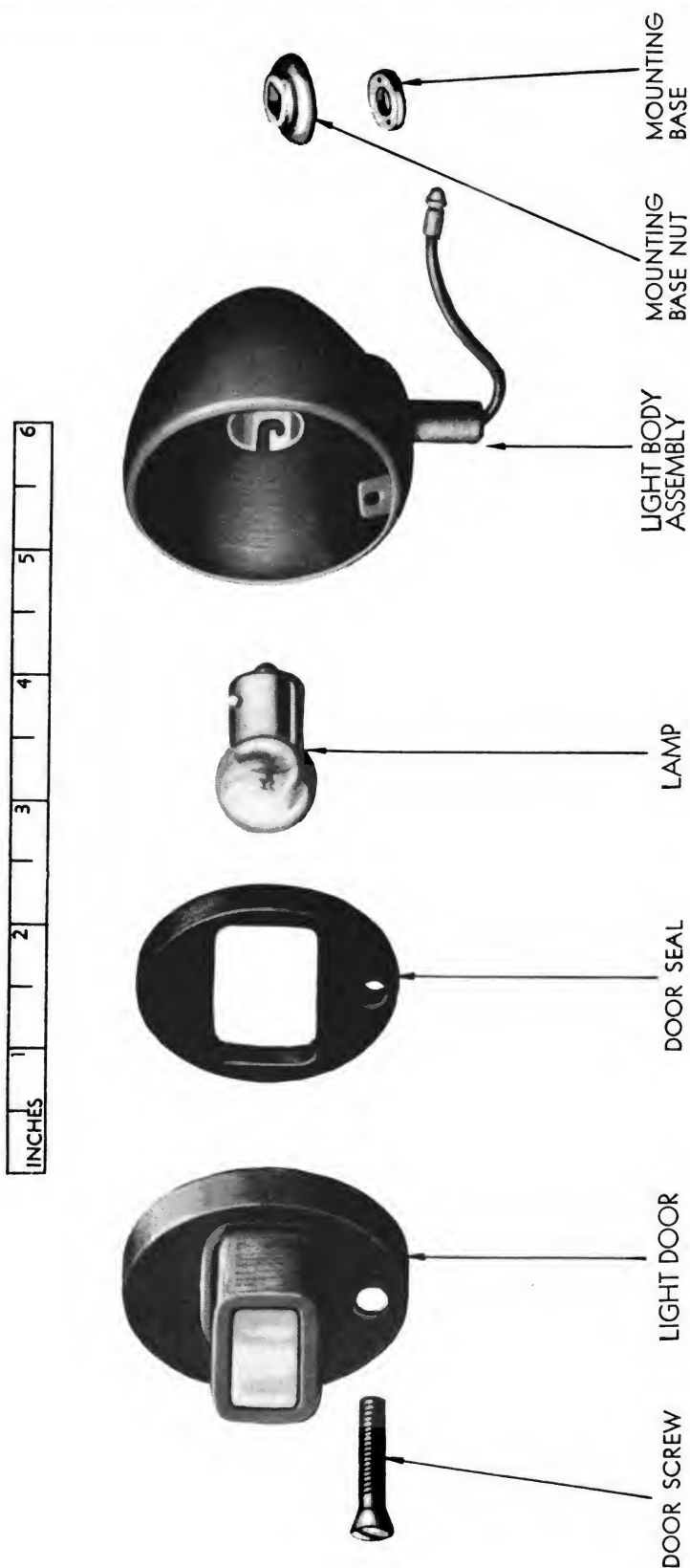


Figure 155—Parts of the Spotlight

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RA PD 66935

Figure 156—Parts of the Rear Marker Light

## HULL ELECTRICAL SYSTEM

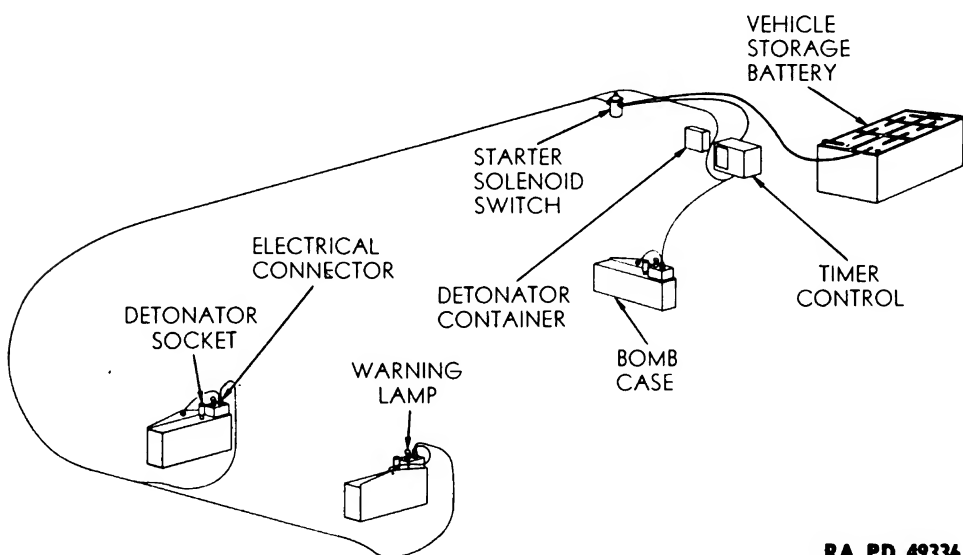
cap and grommet off end of cable. (If new light and cable assembly is to be installed, transfer cap and grommet to new cable. Install grommet with crowned side to top.)

**c. Disassemble Spotlight.** Remove screw and rim lug at top of light rim. Pull rim pins together to spring lens retaining ring out of light body and lower lug on body. Lift lens out of body. If only lamp is to be replaced, push it inward, turn counterclockwise, then pull outward and up to clear diffuser plate. If deflector and reflector are to be removed, pull deflector, reflector and lamp outward at top, and lift the assembly up and out. Remove brass nut holding light wire terminal in lamp socket. Remove deflector, reflector, and lamp from body. At rear of reflector, remove nut and toothed lock washer. Pull lamp with socket and deflector from reflector, noting that a spacer ring is used between socket and reflector.

**d. Inspection and Repair of Components.** No repair of the components is provided for in the event the parts are damaged. A new lamp can be installed, or if the reflector is tarnished or dirty, it can be cleaned by polishing with jeweler's rouge, or suitable cleaning compound. Always use a circular motion, from the center to the outer edge, when cleaning.

**e. Assemble Spotlight Components.** Place spacer ring on socket and push lamp, socket and deflector through reflector, and fasten with nut and toothed lock washer. Install brass nut holding light wire terminal in lamp socket. Install deflector, reflector, and lamp in light body. Place lens in position, install rim over lens, pull rim pins together, and install rim lug and fastening screw.

**f. Installation of Spotlight.** Transfer cap and grommet to light and cable assembly, if a new one is to be installed. Install light cable clip



RA PD 49336

**Figure 157—Demolition Equipment and Wiring**



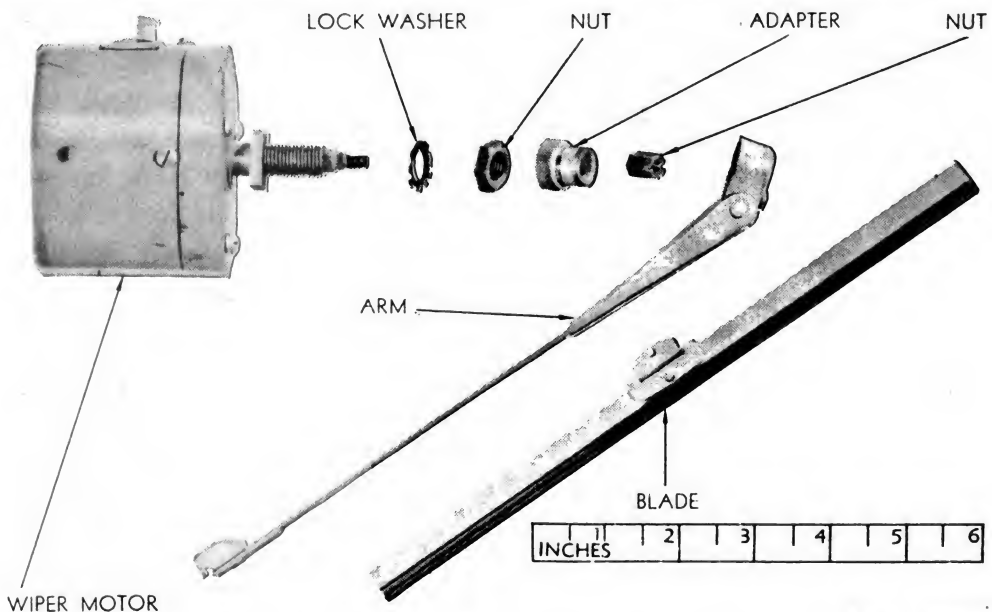
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on under side of light base bolts, fasten cable to clip, and tighten nut. Fasten rubber grommet cap to deck with two metal screws, and connect silver wire terminal to post screw at right rear side of spotlight switch.

**84. MARKER LIGHT.**

**a. Description.** The single lamp, blackout type, rear marker light is connected in the instrument panel light circuit to light only when the instrument panel light switch is pulled out to its operating position. A full rubber gasket seals the light door to the body to prevent the entrance, or accumulation, of moisture within.

**b. Removal of Marker Light.** To remove the lamp only, take out light door screw near bottom of door and lift door and rubber gasket out, at bottom, and upward off light body. Turn the lamp counterclockwise and pull it out of socket. To remove light assembly, pull blue wire out of connector located just inside right corner of vehicle deck coaming. Pull wire with covering loom through hole in coaming. Unscrew ferrule at light and slip loom off wire. Remove light body to bracket nut and toothed lock washer, and lift light assembly and wire out of bracket hole.



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**Figure 158—Electric Windshield Wiper Parts**

**c. Inspection and Repair.** If inspection reveals a burned-out lamp, replace lamp. Inspect wiring for shorts, damage, or broken terminals, and replace light assembly, if it is not satisfactory for further service.

**d. Installation of Marker Light.** Insert wire through bracket hole and place light assembly in position. Install toothed lock washer, and tighten nut securely. Slip ferrule with loom over wire, and screw ferrule on light body. Place wire with covering loom through hole in coaming, and plug wire terminal into connector.

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### 85. BOMB CASE WARNING LIGHTS.

a. When the bomb case warning light is lit, it indicates a fault in the circuit, and the trouble is to be reported at once to higher authority.

### 86. WINDSHIELD WIPER (ELECTRIC).

a. **Description.** This windshield wiper unit consists of a single-speed, sealed motor and a wiper arm assembly. The motor wiring connects to the wiper body at a plug, and to the control switch on the instrument panel through a socket connection mounted on the panel.

b. **Removal of Wiper.** Remove cable at wiper motor by pulling wire terminal end out of the forward junction post on motor. Loosen wiper arm assembly fastening screw located near top of wiper arm. Pull arm out and upward to remove it from wiper shaft. Remove motor shaft end nut and pull off spacer. Remove shaft housing nut and pull wiper motor away from windshield frame.

c. **Inspection and Repair.** While on the vehicle, inspect wiper for proper adjustment of arm and blade, for quiet and cool operation of motor; examine wiper arm for tightness on motor shaft; and check wiper wiring cable for proper contact at forward junction post on wiper motor. Replace wiper motor if faulty. If wiper arm is loose on motor shaft and cannot be adjusted by further tightening of arm fastening screw, install a new arm.

d. **Installation of Wiper.** Place wiper in position, install shaft housing spacer and nut, and tighten securely. Install wiper arm and fasten with set screw. Fasten wire terminal at forward junction post on wiper motor. On completing the installation, operate wiper to check blade travel, and reposition wiper arm on motor shaft as required to give equal blade travel on windshield surface.

### 87. WINDSHIELD DEFROSTER.

a. **Description.** The defroster is of the electric-element detachable type held in position on the windshield by suction cups, and operated by a switch on the instrument panel.

b. **Removal of Defroster.** Remove the defroster by disconnecting wires from terminals on defroster frame, loosening suction cup to frame screws, and squeezing cups while pulling them away from windshield glass.

c. **Inspection and Repair.** If visual inspection discloses a broken glass, broken heating element wires or other damage to frame or wiring, replace the assembly.

d. **Installation of Defroster.** Clean the rear side (glass surface within the driver's compartment) of the windshield. Make certain that glass is warm (70°F). Loosen the four suction cup to frame thumb nuts on defroster unit so that bottom of suction cups will be flat. Cover flat surface of suction cups with adhesive fluid taken from the tube furnished. Hold defroster with wire terminals to right, on rear side of windshield,

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and allow at least 1-inch clearance between top edge of defroster frame and hand windshield wiper control, when at its lowest point of travel. Press defroster firmly against windshield and tighten the four suction cup to frame thumb nuts, pressing each cup firmly against glass to create a vacuum, and seal defroster to windshield. Connect wires to terminals on defroster frame and tighten securely.

**88. ACCESSORY SWITCHES.****a. Voltmeter and Compass Light Switch.**

(1) **REMOVAL OF SWITCH.** Remove battery compartment cover, and disconnect battery ground strap (par. 78). Loosen the two terminal screws, and remove the two black wires from lower post, and the red wire from upper terminal at back of switch. Remove escutcheon nut and ring from front of switch. Push switch body out of panel opening.

(2) **INSTALLATION OF SWITCH.** If a new switch is to be installed, transfer jam nut onto new switch body, and adjust nut so that switch body will be flush with escutcheon nut, when tight. Push switch body through opening and fasten escutcheon nut. Connect the two black wires to lower post, and the red wire to upper terminal. Connect battery ground strap and install battery cover (par. 78).

**b. Windshield Wiper Switch.**

(1) **REMOVAL OF SWITCH.** Remove battery cover and disconnect battery ground strap (par. 78). Loosen the two terminal post screws on back of switch body and remove the orange wire from right post and the black wire from left terminal. Loosen switch button set screw and turn button counterclockwise to remove it from switch operating shaft. Remove lock nut holding switch body to instrument panel. Remove switch from panel, noting the use of toothed lock washer between switch body and rear side of instrument panel.

(2) **INSTALLATION OF SWITCH.** Install switch in position and fasten to instrument panel with lock nut. Make sure a toothed lock washer is installed between switch body and back of panel. The orange wire must be connected to the switch right terminal post and the black wire to the left post. Turn switch button clockwise on operating shaft until tight, then turn it until identification name is horizontal, and tighten the button set screw. Connect battery ground strap and install battery cover (par. 78).

**c. Windshield Defroster Switch.**

(1) **REMOVAL OF SWITCH.** To remove windshield defroster shield switch located on right side of instrument panel, loosen the two terminal post screws on back of switch body. Pull off spade terminal wire ends from each post, noting that wire connected to switch left post runs to bottom post on ignition switch and is fused (10-amp. fuse with insulator). Loosen switch button set screw and turn button counterclockwise off switch operating shaft. Remove lock nut that holds switch body

## HULL ELECTRICAL SYSTEM

to instrument panel. Push switch out back of panel, noting whether an angle plate is used between switch body and rear side of panel for attachment of windshield defroster ground wire.

(2) **INSTALLATION OF SWITCH.** Place switch in position and make sure the angle plate for grounding is installed between switch body and rear side of panel. Install lock nut and connect windshield defroster wires, the black one running from ignition switch to defroster switch left terminal post. Install switch button by turning it clockwise on operating shaft until tight, then turn button until identification name is horizontal, and tighten button set screw.

### d. Spotlight Switch.

(1) **REMOVAL OF SWITCH.** Remove battery cover and disconnect battery ground strap (par. 78). Loosen the two terminal screws on back of switch and remove silver wire spade terminal from right post and black wire from left post. Loosen switch button set screw and remove button from operating shaft by turning button counterclockwise. Remove switch body to panel lock nut, and lift switch out of panel hole. Note that a toothed lock washer is used between switch body and back of instrument panel.

(2) **INSTALLATION OF SWITCH.** Place switch in position with toothed lock washer between switch body and back of panel. Install lock nut and tighten securely. When installing switch button, turn it clockwise on shaft until tight, then turn button until identification name is horizontal, and tighten set screw. Connect silver wire to right terminal screw and black wire to left terminal. Connect battery ground strap and install battery cover (par. 78).

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CHAPTER 6  
SPECIAL TOOLS

Section I

SPECIAL TOOLS

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89. SPECIAL TOOLS.

Tool Name	Federal Stock No.	Mfr's. No.
Anvil, rivet assembly, drive track.....	41-A-281-50	J-3648
Eyebolt, engine lifting.....	41-B-1586-10	J-3614
Guide, bogie wheel, rerailer.....	41-C-1236	J-3633
Protector, synchronizer, transmission.....	41-P-2839-725	J-3643
Puller, bearing and retainer, rear, transmission mainshaft .....	41-P-2900-20	J-3640
Pusher set, crankshaft and crankshaft gear, crankshaft pulley.....	41-P-4710	J-3644
Replacer, axle differential, final drive gear bushing .....	41-R-2390-930	J-3639
Replacer, bearing, needle, track support.....	41-R-2391-29	J-3613
Replacer, inner and outer bearing cup, drive wheel .....	41-R-2394-255	J-3608
Replacer, inner oil seal, bogie wheel.....	41-R-2394-257	J-3646
Replacer, piston pin.....	41-R-2395-100	J-3619
Replacer, water pump housing seat.....	41-R-233-10	C-551
Set, rivet, drive track.....	41-S-2198	J-3647
Wrench, socket, single head, 27/16 in.....	41-W-2940-55	J-3603



## REFERENCES

### STANDARD NOMENCLATURE LISTS

Carrier, light cargo, T15 (Studebaker).....	SNL G-154
Cleaning, preserving and lubrication materials, recoil fluids, special oils, and miscellaneous related items.....	SNL K-1
Soldering, brazing, and welding materials, gases, and related items .....	SNL K-2
Tools, maintenance for repair of automotive vehicles.....	SNL G-27
Tool sets, motor transport.....	SNL N-19
Tool sets, for ordnance service command, automotive shops .....	SNL N-30
Current Standard Nomenclature Lists are listed above. An up-to-date list of SNL's is maintained as the "Ordnance Publications for Supply Index".....	
	OPSI

### EXPLANATORY PUBLICATIONS

Military motor vehicles.....	AR 850-15
List of publications for training.....	FM 21-6
Light cargo carrier T15.....	TM 9-893
Ordnance maintenance: Engine and engine accessories for light cargo carrier model T15 (Studebaker).....	TM 9-1893A

#### Automotive Material.

Automotive electricity .....	TM 10-580
Electrical fundamentals .....	TM 1-455
The motor vehicle.....	TM 10-510

#### Care and Preservation.

Automotive lubrication .....	TM 10-540
Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department .....	TM 9-850
Explosives and demolitions.....	FM 5-25
Motor transport inspections.....	TM 10-545
Product guide .....	OFSB 6-2

#### Decontamination.

Chemical decontamination materials and equipment.....	TM 3-220
Decontamination of armored force vehicles.....	FM 17-59
Defense against chemical attack.....	FM 21-40

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**Maintenance and Repair.**

Automotive power transmission units..... TM 10-585

Maintenance and care of pneumatic tires and rubber  
treads ..... TM 31-200

Sheet metal work, body, fender, and radiator repairs..... TM 10-450

**Storage and Shipment.**

Registration of motor vehicles..... AR 850-10

Rules governing the loading of mechanized and motor-  
ized army equipment, also, major caliber guns, for the  
United States Army and Navy, on open top equipment  
published by Operations and Maintenance Department  
of Association of American Railroads.

Storage of motor vehicle equipment..... AR 850-18

Ordnance field service storage and shipment chart—group  
G major items..... OSSC-G

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(For explanation of symbols, see FM 21-6)

